microbiologytoday

vol34 | aug07
quarterly
magazine of
the society
for general
microbiology

food and water

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fruit and veg that make you sick
rapid molecular detection
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Cover image Water. *Larry Letters / Workbook Stock / Jupiter Images*

Editor Dr Matt Hutchings Editorial Board Dr Sue Assinder, Professor Iain Hagan, Professor Bert Rima Managing Editor Janet Hurst Assistant Editor Lucy Goodchild Design & Production Ian Atherton Contributions are always welcome and should be addressed to the Editor c/o SGM Headquarters, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG Tel. 0118 988 1809 Fax 0118 988 5656 email mtoday@sgm.ac.uk web www.sgm.ac.uk

Advertising David Lancaster, McMillan-Scott PLC, London Office, 10 Savoy Street, London WC2E 7HR t 0207 878 2316 f 0207 379 7118 e david@mcmslondon.co.uk

Regular feature images pp. 103 *SGM*; 107 *Digital Vision/Getty*; 131, 133, 141 *Comstock / Jupiter Images*; 135, 139 *Stockbyte*

 ISSN 1464-0570 Printed by Latimer Trend & Company Ltd, Plymouth, UK

Food and drink

We can't survive without food and water and this issue features various aspects of the microbiology of these staples of life. It complements a theme running through the September SGM meeting in Edinburgh where the plenary has the intriguing title of *Food, fluids, fingers, faeces and flies: food- and water-borne pathogens*. This aims to show how microbiologists are rising to the challenges presented by the pathogens in food and drink that cause suffering to millions of people around the world each year.

Other relevant sessions include a 2-day symposium on *Mechanisms of diarrhoeal disease* and a workshop on the *Molecular detection of food and water pathogens*. The workshop is being supported by Applied Biosystems, Invitrogen and Thermofisher, who will demonstrate their pathogen detection products during the meeting.

To view the full programme of these and the many other sessions at what promises to be a full and exciting meeting, you can browse through the programme booklet enclosed with this magazine.

SGM President is honoured

A symposium entitled *Adventures in Virology and Cancer*, to celebrate the achievements of our President **Robin Weiss**, Professor of Viral Oncology at University College London, is to be held at the Royal College of Physicians on 20–21 September 2007.

Robin has spent most of his life studying retroviruses and worked in cancer research for many years. He has also pioneered aspects of our understanding of HIV and AIDS for which he received the Ernst Chain Award in 2007. He is currently leading a $25 million international research consortium in vaccine discovery, funded by the Bill and Melissa Gates Foundation.

For further information and to register see **http://windeyer.ucl.ac.uk/inf/home.html**

SGM Council

May Meeting Highlights

Outgoing and New Council Members

Professors **Lorna Casselton**, **Tony Minson** and **Nick Mann**, will soon complete their terms on Council, and their input and contributions were gratefully acknowledged. The number of nominations equalled the number of vacancies and so the following will become members of Council at the AGM in September: **Professor Kim Hardie**, University of Nottingham, **Professor David Blackbourn**, University of Birmingham and **Dr Paul Hoskisson**, University of Strathclyde.

Strategy Group

Council had an extensive discussion of the recommendations from the *SGM Strategy Group* which met in March. They approved the setting up of a small working party, chaired by an Elected Member, to carry out a review of the composition of Council, its functions and the responsibilities of members and officers to ensure that these meet current needs. This will report to November Council. Other recommendations to receive support were greater efforts to help microbiologists in developing countries and improvements in liaising with other microbiological societies. Strategy Group had been particularly impressed by the recent BBSRC *Review of Microbial Science*, chaired by *Microbiology* Editor-in-Chief, Charles Dorman, which suggested ways in which learned societies could support UK microbiology.

Meetings

The BBSRC report had also been very useful in informing the recent review of SGM meetings structure and groups led by the Meetings Officer. Hilary Lappin-Scott noted that the review was almost complete and that a full report of the proposals would be made to June Council.

Journals

Council unanimously accepted the recommendation that **Professor Richard M. Elliott**, University of St Andrews, should become the next Editor-in-Chief of *Journal of General Virology*. He will take up the post in January 2008.

SGM Prizes 2008

Council was reminded that nominations are invited for the the Marjory Stephenson Prize Lecture, the Fleming Award and the Peter Wildy Prize for Microbiology Education (see May issue of *Microbiology Today* or the SGM website for details). The closing date is **30 September 2007**, and the decisions will be made by Council in November.

SGM *Annual Report* 2006

Officers presented their draft Annual Reports for 2006 to Council. These were accepted and a copy of the entire *Annual Report* is enclosed with this issue of *MT*.

***Ulrich Desselberger**, General Secretary*

Opposition MP visits Marlborough House

We were pleased to welcome **Charles Hendry MP**, Shadow Minister for Energy, Science and Technology, to Marlborough House in April. Mr Hendry asked to visit the SGM after receiving a copy of *Microbiology Research Matters*, a publication that the SGM circulated last year to highlight the important work of young microbiology researchers.

He met with Ron Fraser, Janet Hurst and Sue Assinder (SGM Education Officer), and they had a very full discussion that ranged from microbiology education in schools and universities through to the potential impact of open access publishing. We took the opportunity to give him copies of other SGM publications and he was keen to be added to the list of MPs who regularly receive a copy of *Microbiology Today*.

Mr Hendry expressed his support for the work of the SGM and asked that we contact him in the future if he could be of any help in raising the profile of microbiology issues within Government.

Sue Assinder

▶ From left to right: Ron Fraser, Janet Hurst, Charles Hendry MP and Sue Assinder at their recent meeting at Marlborough House. *Ian Atherton*

Science and the Welsh Assembly

The 2007 event, organized by the Royal Society of Chemistry, took place on Tuesday 22 May, at the Wales Millennium Centre and the Senedd in Cardiff Bay. Supported by several other organizations, including SGM, *Science and the Assembly* events aim to strengthen links between the Welsh Assembly and the scientific community in Wales.

This year's theme was Energy. This is a topic relevant to a wide variety of scientific fields, not least microbiology. Afternoon talks included solar energy, alternative fuel, marine renewable energy and Wales in the forefront of energy. SGM participated in the exhibition at the Senedd, giving the Assembly Members a chance to ask *What has microbiology got to do with energy?* From biofuel production to waste cleanup, microbial life is an important contributor to climate change and can be used to help control it.

Speakers and delegates agreed unanimously that progress is dependent on improving the way information on science is obtained and used by the Welsh Assembly, concluding that '*Wales needs its own Chief Scientific Adviser*'. By all accounts, the event was a success and, as RSC President Jim Feast commented, a great way to show the Assembly that '*science matters*'.

***Lucy Goodchild**, SGM*

▲ The Millennium Centre, Cardiff. *Ian Britton, Freefoto*

Annual General Meeting 2007

The Annual General Meeting of the Society will be held on **Tuesday 4 September** at the Society's 161st meeting at Edinburgh University.

Agenda papers, including reports from Officers and Group Conveners, the accounts of the Society for 2006 and a resolution to amend the Memorandum and Articles of Association are published in the separate *Annual Report* booklet distributed to all members with this issue of *Microbiology Today*.

News of Members

Elected Fellow of the Royal Society

Congratulations to **Professor E. Richard Moxon**, University of Oxford, on his election as a Fellow of the Royal Society. He is distinguished for his work in bacterial genetics, the identity of vaccine candidates, and for pioneering important vaccine programmes. Professor Moxon will deliver the Fred Griffith Review Lecture at the SGM meeting in Edinburgh (see right).

Queen's Birthday Honours 2007

Professor James M. Lynch, Programme Coordinator, Biological Resource Management, Organization for Economic Co-operation and Development, has been awarded an OBE.

Deaths

The Society notes with regret the following deaths:

Mr Alan D. Court, Rowley Regis, West Midlands (member since 1999).

Professor Michael C.W. Evans, University College London (member since 1964).

Dr Douglas Snow, Winchester, (member since 1947).

Dr I.L. Stevenson, Ottawa, Canada (member since 1957).

Dr Philippa M.B. White, Norwich Community Hospital (member since 1988).

Prize Lectures

Fred Griffith Prize Lecture

Professor Richard Moxon will deliver his prize lecture, entitled *Bacterial variation, virulence and vaccines*, on Tuesday 4 September at the Society's meeting at Edinburgh University. The Fred Griffith Lecture is awarded in recognition of long and distinguished service in any area of microbiology.

E. Richard Moxon is Chairman of Paediatrics at the University of Oxford, Head of the Molecular Infectious Diseases Group at the Weatherall Institute of Molecular Medicine and Director of the Oxford Vaccine Group.

After graduation from St John's College, Cambridge (1963), and St Thomas's Hospital, London (1966), he trained as a paediatrician, sub-specializing in infectious diseases, and began laboratory research in 1971 at the Children's Hospital Medical Center in Boston, USA. His career continued at Johns Hopkins University (1974–1984) before returning to the UK to take up the Action Research Professorship of Paediatrics. Using models of infection, classical genetics and whole-genome sequences, his laboratory has made contributions to the pathogenesis and prevention of bacterial diseases caused by *Haemophilus influenzae* and *Neisseria meningitidis*.

Peter Wildy Prize for Microbiology Education

Professor Simon Cutting will deliver his prize lecture entitled *Ten Years in Vietnam*, on Wednesday 5 September at the Society's meeting at Edinburgh University. The Peter Wildy Prize is awarded for an outstanding contribution to microbiology education.

Simon Cutting writes: I currently hold a Chair in Molecular Microbiology at the Royal Holloway University of London where my research interests are primarily with recombinant vaccines. Just before starting at the RHUL I made my first trip, as a tourist, to Vietnam in 1995. This was after 10 years in the USA which included a 6-year postdoc with Rich Losick at Harvard, studying the genetics of sporulation in *B. subtilis*. Before this I was lucky enough to work with Joel Mandelstam and Jeff Errington at Oxford where I obtained my DPhil.

The war-torn, yet beautiful and beguiling country of Vietnam was once home to not one but four Pasteur Institutes. My first visit was to the Nha Trang Institute where the renowned microbiologist Alexandre Yersin (as in *Yersinia pestis*) lived and worked for 40 years. I have since been back to Vietnam over 25 times. Inspired by the commitment of many young Vietnamese students to study I held a training workshop in 1996 on molecular biology methods. The Vietnamese relished the opportunity for interaction with Western scientists and so began a programme of workshops in Ho Chi Minh City (aka Saigon) and Hanoi. The 12th workshop takes place at the Hanoi University of Science this August. Over 60 Western scientists have now participated in the workshops, giving lectures as well as organizing short practical classes. Six Vietnamese students have become PhD students in European labs. I am very grateful to the SGM for sponsoring half of these workshops to date. My time in Vietnam has led to several funded research collaborations, but my interests there go beyond teaching and research. I have started working on a literary project involving an English resident of Vietnam some 100 years ago whose husband was the first doctor to work with Yersin in Vietnam.

Grants

Upcoming deadlines

The deadline is **21 September 2007** for receipt of applications to the following schemes:

- International Development Fund
- Watanabe Book Fund
- Elective grants
- President's Fund for Research Visits

Postgraduate Student Meeting Grants

Applications for a grant to attend the SGM's Edinburgh meeting (3–6 September) must be received by **31 August 2007**.

Other schemes in brief

Scientific Meetings Travel Grants

The scheme supports early career microbiologists wishing to present work at a scientific meeting, either in the UK or abroad. See rules on the website for eligibility criteria.

SGM has a wide range of grant schemes to support microbiology. See **www.sgm.ac.uk** for details and closing dates.

Any enquiries should be made to the Grants Office, SGM, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG (t 0118 988 1821; f 0118 988 5656; e grants@sgm.ac.uk).

Seminar Speakers Fund

The Fund supports talks on microbiological topics in departmental seminar programmes.

Applications will be dealt with on a first come, first served basis during the academic year.

Education Development Fund/PUS Awards

Grants are available to members for projects intended to lead to an improvement in the teaching of any aspect of microbiology relevant to education in the UK. Funding is also available for small projects to promote the public understanding of microbiology, such as workshops, talks, demonstrations, leaflets, and activities at science festivals.

Applications will be considered on a first come, first served basis during the calendar year.

Retired Member Conference Grants

Retired members may apply for a grant to attend one SGM meeting each year. The award covers en-suite accommodation and the Society dinner, up to a maximum of £250.

Applications for grants to attend the SGM meeting at Edinburgh University are now invited.

Technician Meeting Grants

These grants support attendance by eligible technicians at one SGM meeting each year.

Applications for grants to attend the SGM meeting at Edinburgh University are now invited.

New STIs Briefing

The latest in our series of 'briefings' on topical issues in microbiology is now available.

The illustrated A4 flier on sexually transmitted infections covers bacterial diseases (chlamydia, gonorrhoea and syphilis) on one side and viral diseases (HIV/AIDS, genital warts and genital herpes) on the other. It sets out the basic facts about each infection, including cause, symptoms, incidence, significance, transmission and treatment (if any). Copies of the briefing have already been sent out to members of both houses of parliament and to school members of SGM. The leaflet has been so popular that a reprint has already proved necessary.

SGM Briefings are succinct documents published as part of the Society's Microbiology Awareness Campaign, which aims to highlight important subjects relating to microbiology to opinion-formers, educationalists and the general public. Other briefings cover: *Clostridium difficile*, *Hand hygiene*, *Malaria*, *Measles*, *MRSA* and *TB*. They are researched and produced in the External Relations Office, but all are checked by experts among the membership before being published.

Email **y.taylor@sgm.ac.uk** if you would like a copy of any of these titles.

The saga of the longest running experiment continues…

Tim Mahony, a member based in Australia, enjoyed the description of the serial passage of the rabies virus in Saigon from 1891 to 1953 in the February issue of *Microbiology Today*. The follow up mention of the cropping experiments at Rothamsted that have been running for 164 years also proved amazing in the May issue.

'It made me recall a physics experiment that I had read about a couple of years ago that had received an Ignoble prize. Due to the vagueness of my memory it took a while to find out the details, but it involved an experiment started in 1930 at the University of Queensland (Brisbane, Australia) which is listed in the *Guinness Book of Records* as the world's longest running experiment (see **www.physics.uq.edu.au/pitchdrop/pitchdrop.shtml**) I guess it must depend on the criteria for the *Guinness Book of Records* as to what holds the record, perhaps there are field and laboratory-based categories! And of course this experiment is not biological. Email **timothy.mahony@dpi.qld.gov.au**

Federation of Infection Societies Conference 2007

28–30 November
Cardiff City Hall

The Scientific Organizing Committee, under the leadership of Del Ala'Aldeen, SGM, with input from many of the FIS societies, has put together an exciting programme focusing on a wide range of topics of current importance in the field of infection.

The conference will follow the usual format, with multidisciplinary plenary sessions, a variety of challenging interactive workshops, named lectures, sponsored satellite symposia and a trade exhibition. There will be oral presentations, including clinical lessons, infection control/outbreak control lessons and free papers, together with an increased number of poster walks. The event will be rounded off by an enjoyable social programme.

Abstract submission is now invited.

Online registration is open.

Online accommodation booking is also available.

Check out **www.fis2007.org.uk** for full details of the programme and arrangements for the event.

IUMS Congresses 2008

Microbes: then, now and hereafter

Istanbul

XII International Congress of Bacteriology and Applied Microbiology
XII International Congress of Mycology
5–9 August

XIV International Congress of Virology
10–15 August

www.iums2008.org

Early career SGM members who are presenting work at the congresses may be eligible for a Scientific Meetings Travel Grant (see **www.sgm.ac.uk/grants/smtg.cfm**).

Careers Conferences 2007

3 November
University of Leeds

17 November
King's College London

1 December
University of Bristol

Aimed at life science under- and postgraduate students, each conference includes widely varying talks on career choices and further training, plus a small exhibition by a range of organizations. A CV review service is also available by prior arrangement. SGM is involved in organizing the events and will have a stand in the exhibition.

Cost: £12 (*earlybird rate – 2 weeks before the date of each conference*) or £15 (*full rate*). The registration fee includes refreshments and lunch.

Details and a booking form are available at **www.bsf.ac.uk/careers/careersconf.htm**

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council**06–07**

Officers

President – Prof. Robin Weiss
Division of Infection and Immunity, University College London, 46 Cleveland Street, London W1T 4JF
t 0207 679 9554; **f** 0207 679 9555; **e** r.weiss@ucl.ac.uk

Treasurer – Prof. Colin R. Harwood
School of Cell and Molecular Biosciences, University of Newcastle Medical School, Framlington Place, Newcastle upon Tyne NE2 4HH
t 0191 222 7708; **f** 0191 222 7736; **e** colin.harwood@ncl.ac.uk

General Secretary – Dr Ulrich Desselberger
c/o SGM Headquarters
e u.desselberger@sgm.ac.uk *or* udesselberger@btinternet.com

Scientific Meetings Officer – Prof. Hilary M. Lappin-Scott
Dept of Biosciences, University of Exeter, Geoffrey Pope Building, Exeter EX4 4QD
f 01392 263434; **e** h.m.lappin-scott@exeter.ac.uk

International Secretary – Prof. George P. C. Salmond
Dept of Biochemistry, University of Cambridge, Tennis Court Road, Building O, Downing Site, Cambridge CB2 1QW
t 01223 333650; **f** 01223 766108; **e** gpcs@mole.bio.cam.ac.uk

Professional Affairs Officer – Dr Geoffrey C. Schild
e the.schilds@btinternet.com

Education Officer – Dr Susan J. Assinder
Academic Development Unit, University of Wales – Bangor, Trefenai, School of Education, Normal Site, Bangor, Gwynedd LL57 2PZ
t 01248 382604; **f** 01248 370731; **e** s.assinder@bangor.ac.uk

Editor, *Microbiology Today* – Dr Matt Hutchings
School of Biological Sciences, University of East Anglia, Norwich Research Park, Norwich NR4 7TJ
t 01603 592257; **e** m.hutchings@uea.ac.uk

Editor-in-Chief, *Microbiology* – Prof. Charles J. Dorman
Dept of Microbiology, Moyne Institute, Trinity College, Dublin 2, Ireland
t +353 1 608 2013; **f** +353 1 679 9294; **e** cjdorman@tcd.ie

Editor-in-Chief, *JGV* – Prof. Geoffrey L. Smith
Dept of Virology, Faculty of Medicine, Imperial College London, St Mary's Campus, Norfolk Place, London W2 1PG
t 0207 594 3972; **f** 0207 594 3973; **e** glsmith@ic.ac.uk

Editor-in-Chief, *JMM* – Prof. Ian R. Poxton
Medical Microbiology, Centre for Infectious Diseases, University of Edinburgh College of Medicine and Veterinary Medicine, The Chancellor's Building, Room SU311, 49 Little France Crescent, Edinburgh EH16 4SB
t 0131 242 9122; **f** 0131 242 9122; **e** i.r.poxton@ed.ac.uk

Members

Prof. Mike R. Barer
Infection, Immunity and Inflammation, University of Leicester, Medical Sciences Building, PO Box 138, University Road, Leicester LE2 4FF
t 0116 252 2933; **f** 0116 252 5030; **e** mrb19@le.ac.uk

Prof. Lorna A. Casselton
Dept of Plant Sciences, University of Oxford, South Parks Road, Oxford OX1 3RB
t 01865 275109; **f** 01865 275074; **e** lorna.casselton@plants.ox.ac.uk

Prof. Neil A. R. Gow
School of Medical Sciences, Institute of Medical Sciences, University of Aberdeen, Aberdeen AB25 2ZD
t 01224 555879; **f** 01224 555844; **e** n.gow@abdn.ac.uk

Prof. Iain M. Hagan
Paterson Institute for Cancer Research, Wilmslow Road, Manchester M20 4BX
t 0161 446 8193; **f** 0161 446 3109; **e** ihagan@picr.man.ac.uk

Dr Richard M. Hall
Biological Reagents and Assay Development (BR&AD), GlaxoSmithKline R&D, New Frontiers Science Park – North Site SC1, H31/1-047 (Mail Code H31111), Third Avenue, Harlow, Essex CM19 5AW
t 0127 962 7172; **f** 0127 962 7014; **e** richard.m.hall@gsk.com

Prof. Nicholas H. Mann
Dept of Biological Sciences, University of Warwick, Coventry CV4 7AL
t 024 76 523526; **f** 024 76 523701; **e** n.h.mann@warwick.ac.uk

Prof. Tony C. Minson
Division of Virology, Dept of Pathology, University of Cambridge, Tennis Court Road, Cambridge CB2 1QP
t 01223 336920; **f** 01223 336926; **e** acm@mole.bio.cam.ac.uk

Dr Catherine O'Reilly
Dept of Chemical and Life Sciences, Waterford Institute of Technology, Cork Road, Waterford, Ireland
t +353 51 302858; **f** +353 51 378292; **e** coreilly@wit.ie

Prof. Petra C. F. Oyston
TL Molecular Bacteriology, Dstl, B07A Microbiology, Porton Down, Salisbury SP4 0JQ
t 01980 613641; **f** 01980 614307; **e** pcoyston@dstl.gov.uk

Prof. Rick E. Randall
School of Biology, Biomolecular Sciences Building, University of St Andrews, North Haugh, St Andrews, Fife KY16 9ST
t 01334 463397; **f** 01334 462595; **e** rer@st-andrews.ac.uk

Prof. Bert K. Rima
School of Biology and Biochemistry, Medical Biology Centre, The Queen's University of Belfast, 97 Lisburn Road, Belfast BT9 7BL
t 028 9097 5858; **f** 028 9097 5877; **e** b.rima@qub.ac.uk

Prof. Katherine A. Smart
Division of Food Science, School of Biosciences, University of Nottingham, Sutton Bonington Campus, Loughborough LE12 5RD
t 01159 516214; **f** 01159 516162; **e** katherine.smart@nottingham.ac.uk

group**conveners**

Cells & Cell Surfaces – Dr Ian R. Henderson
Division of Immunity and Infection, University of Birmingham Medical School, Edgbaston, Birmingham B15 2TT
t 0121 414 4368; **f** 0121 414 3599; **e** i.r.henderson@bham.ac.uk

Clinical Microbiology – Prof. Dlawer Ala'Aldeen
Molecular Bacteriology and Immunology Group, Division of Microbiology, School of Molecular Medical Sciences, University Hospital, Nottingham NG7 2UH
t 0115 823 0748/0771 (secretary); **f** 0115 823 0759; **e** daa@nottingham.ac.uk

Clinical Virology – Prof. Judy Breuer
ICMS Centre for Infectious Disease, Barts and the London Medical School, 4 Newark Street, London E1 2AT
t 0207 882 2308; **f** 0207 882 2181; **e** j.breuer@qmul.ac.uk

Education & Training – Prof. Joanna Verran
Dept of Biology, Chemistry and Health Science, Manchester Metropolitan University, Chester Street,
Manchester M1 5GD
t 0161 247 1206; **f** 0161 247 6325; **e** j.verran@mmu.ac.uk

Environmental Microbiology – Prof. Geoffrey M. Gadd
Division of Environmental and Applied Biology, Biological Sciences Institute, School of Life Sciences, University of Dundee, Dundee DD1 4HN
t 01382 344765; **f** 01382 348216; **e** g.m.gadd@dundee.ac.uk

Eukaryotic Microbiology – Dr Alastair Goldman
Molecular Biology & Biotechnology, University of Sheffield, Firth Court, Sheffield S10 2TN
t 0114 222 2779; **e** a.goldman@shef.ac.uk

Fermentation & Bioprocessing – Prof. Chris J. Hewitt
Dept of Chemical Engineering, Loughborough University, Loughborough LE11 3TU
t 01509 222503; **e** c.j.hewitt@lboro.ac.uk

Food & Beverages – Prof. Bob A. Rastall
Dept of Food Biosciences, University of Reading, PO Box 226, Reading RG6 6AP
t 0118 378 6726; **f** 0118 931 0080; **e** r.a.rastall@reading.ac.uk

Irish Branch – Dr Evelyn Doyle
School of Biology and Environmental Science, Ardmore House, University College Dublin, Belfield, Dublin 4, Ireland
t +353 1716 1300; **f** +353 1716 1183; **e** evelyn.doyle@ucd.ie

Microbial Infection – Dr Nick Dorrell
Pathogen Molecular Biology Unit, Dept of Infectious and Tropical Diseases, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT
t 0207 927 2838; **f** 0207 637 4314; **e** nick.dorrell@lshtm.ac.uk

Physiology, Biochemistry & Molecular Genetics – Prof. George P. C. Salmond
Dept of Biochemistry, University of Cambridge, Tennis Court Road, Building O, Downing Site, Cambridge CB2 1QW
t 01223 333650; **f** 01223 766108; **e** gpcs@mole.bio.cam.ac.uk

Systematics & Evolution – Prof. Niall A. Logan
Dept of Biological and Biomedical Sciences, Glasgow Caledonian University, Cowcaddens Road, Glasgow G4 0BA
t 0141 331 3207/8510 (admin assistant); **f** 0141 331 3208; **e** n.a.logan@gcal.ac.uk

Virus – Prof. Rick E. Randall
School of Biology, Biomolecular Sciences Building, University of St Andrews, North Haugh, St Andrews, Fife KY16 9ST
t 01334 463397; **f** 01334 462595; **e** rer@st-andrews.ac.uk

Viruses are a more common cause of water-borne illness than is generally realized. Detecting them and relating cause to effect are not easy either, as **Peter Wyn-Jones** explains.

► *Photos.com / Jupiter Images*

Viruses in water: the imaginative in pursuit of the fugitive

Water-borne enteric viruses are probably not the first micro-organisms which spring to mind when thinking of polluted water. Cholera, typhoid and cryptosporidiosis are more prominent in the public mind, though viruses are likely to have been the cause of many outbreaks of water-borne disease. The difficulty has, until comparatively recently, been proving the link between the water and the sick person.

The aquatic environment contains an ever-changing kaleidoscope of micro-organisms, including those present as a result of pollution by sewage and agricultural run-off. The threat of cholera and typhoid as the principal diseases transmitted by water in the cities of the 19th and early 20th centuries, and eventually the relative ease of detecting salmonellae and vibrios in water all eclipsed the idea that other infections, prevalent in the communities but not well characterized, might also be water-borne. In the first half of the 20th century epidemics of poliomyelitis were common in Europe and the US and many were associated, albeit anecdotally, with ingestion of polluted water. The most notable victim was President Franklin Roosevelt, who developed symptoms after falling in the water during a boating holiday. Though it is now thought that the disease might not have been polio, Roosevelt supported campaigns for research into the disease, which culminated in the Salk and Sabin vaccines.

Today, pollution of bathing waters by sewage produces a perceived public health problem internationally. Many countries depend on tourism for much of their national income and a large part of their GDP is derived from seasonal tourism around their coastlines. Pressure group activity and public health concerns about recreational water quality have driven governments, water undertakings and the European Union to continue improvements in bathing water quality begun in the 1970s with the first Bathing Water Directive, and there are at present nearly 28,000 bathing waters covered by the legislation.

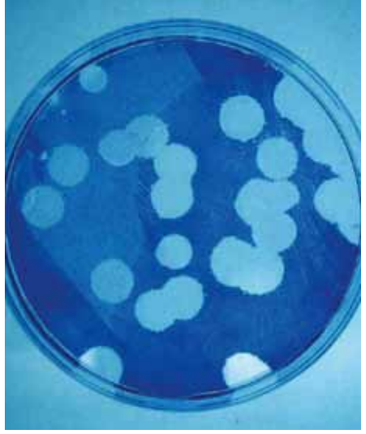
Viruses are more environmentally stable than bacteria and so will persist in waters where only low levels of bacteria may be found. Studies done in the 1990s suggested that any gastrointestinal symptoms experienced by bathers following immersion in water were due to viral, rather than bacterial, infection.

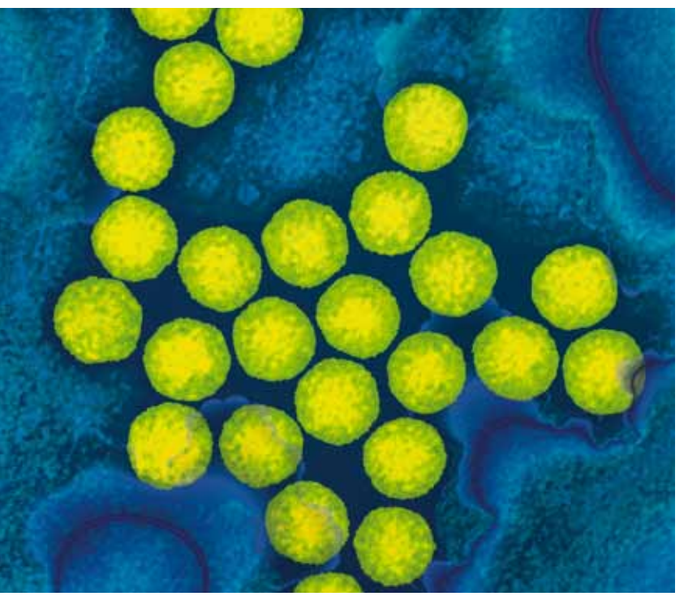
Everyone carries their own population of enteric viruses. Like enteric bacteria, they generally do no harm and are shed in the faeces. Since they are very common and therefore shed by most of the population they will be found in any water polluted by domestic sewage. In addition to those harmless viruses, some enteric viruses cause disease, usually gastroenteritis. They also will be shed by those unfortunate enough to catch them, but for only short periods. They will therefore be present less often in sewage, and less often in polluted water. However, they may be just as robust as the less harmful types and so will survive for extended periods of time.

There are many groups of enteric viruses. The enteroviruses and adenoviruses are common; most cause few symptoms in healthy adults, and are often present in sewage-polluted water. Conversely, hepatitis A virus and norovirus are examples of pathogenic viruses which are shed by infected individuals and which are usually associated only with illness. Study of these viruses in the local sewage thus gives us a picture of the virological state of the population served by the local treatment plants. Recognition of the occurrence of enteric viruses in the environment is therefore of use in epidemiological surveys where exposure to microbial agents is considered. The microbiological quality of bathing waters continues to be measured in terms of bacteria, *E. coli* and enterococci in the new Bathing Water Directive, and methods for measuring the levels of these organisms are straightforward. However, few people become ill through ingestion of water-borne enterococci and there remains a case for the detection of (a) pathogens rather than indicators and (b) viral indicators which more closely reflect the pathogenic viruses in polluted water.

Outbreaks

The association of the presence of the causative agent in water with its presence in an affected individual has been one of the main stumbling blocks in proving that water-borne viruses





▲ *Top left* A cartridge packed with glass wool ready for filtration of 10 litre water sample. *Top right* Poliovirus plaques in a BGM cell culture. *P. Wyn-Jones*

▲ *Centre* The Netherlands water fountains where children acquired norovirus infection. *Ana Maria de Roda Husman, RIVM*

▲ *Bottom* Coloured transmission electron micrograph of a cluster of polio virus particles. *Dr Linda Stannard, UCT / Science Photo Library*

cause disease in recreational waters or in drinking water. There have been a number of outbreaks which illustrate the progress made in the last few years in solving this problem.

Drinking water. Bramham is a village in North Yorkshire, UK. In 1980 about 3,000 of its 12,000 population became ill with diarrhoea and vomiting. Investigations showed that sewage had leaked from a cracked pipe and contaminated the local drinking water supply at the same time as a chlorination failure occurred. In retrospect, the epidemiological picture strongly suggests a norovirus outbreak, but at the time no virology was done on stool samples, nor on water nor sewage, so the exact cause remained unsolved.

In Riding Mill, Northumberland, UK, in 1990, 229 people were made ill by the drinking water supply being inadvertently connected to the untreated (and polluted) river water. Again, the epidemiology suggested a viral cause, but no environmental investigations were done.

By the mid-1990s it was possible to detect water-borne enteropathogenic viruses much more reliably. In Heinavesi, Finland, in 1998, almost 3,000 people became ill through their drinking water supply becoming polluted with sewage. Finland is a land of over 18,000 lakes and many small communities exist on their shores. Water flowing from one lake to another has historically been regarded as sufficient dilution for the relatively small quantities of sewage allowed to enter the water, and chlorination was not widely practised until recently. But the 1998 outbreak showed that consumption of polluted water could lead to viral diseases, and cause and effect were confirmed by finding the same virus (norovirus genogroup II) in the drinking water and in some of the affected individuals.

Recreational waters. Recreational waters have also been implicated in norovirus outbreaks; in Vermont, in 2004, 53 people (mostly children) became ill after swimming club activities at a local pool; although the virus was not recovered from the water, the children all had the same strain of virus. The cause was a faulty chlorination unit coupled with poor management practices. In the Netherlands, in 2002, 90 children had diarrhoea and vomiting after playing in a recreational water fountain. No *E. coli* or enterococci were found in drinking water samples at the playground site, but samples from the fountain had bacterial counts that exceeded the EU limits, and the same norovirus was found in the water fountain samples as in faecal samples taken from the affected children.

Viruses are the most likely causes of disease acquired from ingesting polluted water while bathing

Methods

Detection of water-borne viruses is technically much more demanding than finding bacteria. Viruses in faeces are normally present in lower concentrations than bacteria, even in disease states. The detection process consists of at least two stages: concentration of virus in the water sample and detection of viruses in the concentrate. The sample volume will vary according to the likelihood of finding virus, so for drinking water it is common to concentrate 100–1,000 litres, while for potentially polluted river water or treated sewage effluent 10 litres will be sufficient.

There are many methods for concentration of viruses in water; it may be done by filtration through membranes which retain virus by electrostatic adsorption, through resin-based membranes, or through other filtration matrices. Glass wool, packed into a column, is a very cheap and effective filtration matrix. Developed in France in connection with drinking water analysis, the technique has found widespread use in concentration of many virus types from a range of waters. Virus is eluted from filters into a small volume (usually 100–200 ml) of high pH buffer, sometimes containing skimmed milk or beef extract, and is then further concentrated to between 1 and 10 ml, depending on the detection procedure.

Other concentration methods include ultrafiltration and ultracentrifugation. The former is useful for pH-intolerant viruses and is currently being trialled as a way of concentrating avian orthomyxoviruses in water, even though these viruses may be more pH-resistant than their human counterparts. Ultracentrifugation is a catch-all method and has revealed the presence of viruses in relatively small volumes of water. It is not a technique likely to find widespread use in routine environmental monitoring laboratories however, owing to the high cost of the equipment.

Most virus detection is done by molecular biological methods, principally using the reverse transcriptase polymerase chain reaction (RT-PCR), though nucleic acid sequence-based amplification (NASBA) and loop-mediated isothermal amplification (LAMP) techniques are also used. Cell culture, used to detect water-borne enteroviruses since the 1970s, is used less since it is restricted to very few virus types and takes a long time to produce results. Whichever approach is used however, the main problem is one of inhibitors in the concentrate. These are usually soil-derived humic or fulvic acids which inhibit the RT-PCR (usually the RT) and which are difficult to remove. Their presence may therefore lead to a false-negative result, and suitable amplification controls need to be used to guard against this. Substances toxic to cell cultures may be removed by treating the concentrate with chelating agents in chloroform, but this may have an adverse effect on the virus too.

Viruses and water quality

Methodology has now advanced sufficiently to make routine virus detection in water a practicable proposition, and it has moved from the possible to the feasible in respect of establishing a virus standard for use in regulatory contexts. The microbiological parameters were reduced to *E. coli* and enterococci in the 2006 revision of the Bathing Water Directive and the enterovirus standard of the 1976 Directive was removed, which was scientifically sensible since it had been based on precarious assumptions. The new Directive contains Article (14) which requires the European Commission to report by 2008 on (*inter alia*) scientific progress relating to viruses in water. In pursuit of this task the Commission funded the FP6 Project Virobathe (www.virobathe.org) which involved 16 laboratories across Europe and which has just finished. The aim was to devise a routine method for detecting adenoviruses and noroviruses in recreational waters. The study compared different approaches and produced protocols for use in routine environmental virology laboratories. It clearly demonstrated that routine virus analysis is a feasible proposition. It is therefore possible to begin the task of linking enterococci levels (which are the only reliable indicators of health effects in bathing waters) to virus levels (since viruses are the most likely causes of disease acquired from ingesting polluted water while bathing) and so to increase confidence in monitoring programmes designed to improve water quality and protect the public health.

Peter Wyn-Jones
Senior Research Fellow, IGES,
University of Wales Aberystwyth,
Aberystwyth SY23 2DB, UK
(e pyw@aber.ac.uk)

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Brand X / Jupiter Images

Fruits and vegetables that make you sick… what's going on?

If you are fortunate enough to have access to fresh fruits and vegetables from your own garden, a friend's garden, or from a local farmer's market operating during the peak of the growing season, you are aware of the wonderful appearance, smell and taste of produce picked and consumed the same day. This is certainly a special treat, but an abundant year-round supply of high-quality fresh leafy vegetables such as lettuces, baby spinach and other produce intended for raw consumption by large populations in the United States and Europe is dependent upon land in special geographic regions with ideal soil and climate conditions. This year-round supply is due to the vision, innovation and hard work of people developing new ways to meet the demand of ever-expanding populations for fresh produce. This includes the processors who must clean, package and deliver rapidly fragile food items large distances to consumers in many parts of the world. Minimally processed, bagged produce has been a new innovation to help meet this growing demand.

Leafy vegetables are harvested by hand, and sometimes by machines (mowers), then transported to a processor where they are mixed intact, or cut into pieces for mixing with similar items from other fields, then washed multiple times in large flumes of water, dried and packed in plastic bags of special types for preserving the product. The bagged products are transported under cool conditions across the US or to other countries. The minimally processed, ready-to-eat, fresh produce industry has grown exponentially into a multi-billion dollar business in the US, and is growing rapidly in Europe and other parts of the world. As demand has increased, growers have had to contend with old and new plant diseases, finding and maintaining adequate water supplies, and frost, heat, flooding or other weather conditions that destroy crops. Growers and others involved in food production must meet continued challenges to succeed in providing high-quality products to consumers across wide regions. However, even when all of these challenges are met successfully, there remains another challenge that recently has been in the news and has tested everyone in different sectors of the US fresh produce industry: to produce safe food. The microbial safety of leafy greens and other vegetables has gained ever increasing attention as a result of outbreaks of disease.

Outbreaks associated with leafy vegetables and tomatoes

Anyone who reads or listens to the news is aware that large, multi-state outbreaks have occurred in the US as a result of leafy vegetables or tomatoes contaminated with micro-organisms.


Brand X / Jupiter Images

Pre-packed and ready to eat fruit and vegetables are a great timesaver in our busy world, but as **Robert Mandrell** describes, they are not so convenient if they carry pathogens that make you ill.

Indeed, there were 10 outbreaks between 2002 and 2006 associated with leafy vegetables contaminated by *Escherichia coli* O157:H7 and multiple outbreaks associated with fresh tomatoes contaminated with different types of *Salmonella*. The sources of the leafy vegetables and tomatoes implicated in the outbreaks were farms in California or mid-Atlantic US states, respectively. More than 200 people in 26 US states were identified as sickened by *E. coli* O157:H7 during the investigation of a 2006 outbreak due to contaminated bagged baby spinach. This became the largest of a series of outbreaks involving minimally processed bagged leafy vegetables. This outbreak, and recurring outbreaks associated with tomatoes or leafy vegetables grown on the east or west coasts of the US, suggest that the micro-organisms causing them may be present somewhere in the nearby environment. This situation is perceived as unusual and was unanticipated by growers and processors, and has forced many affected parties to ask what's going on? What has changed?

In the 2006 outbreak, intensive investigation of farms, ranches and processors possibly linked to the contaminated spinach led to the conclusion that this, and perhaps many previous outbreaks, occurred as a result of contamination of leafy vegetables in the field (in other words, 'pre-harvest'), and not during transport, by workers or during processing. Although this is a critically important finding, it also complicates strategies for eliminating illnesses and outbreaks. The valleys where most leafy vegetables are grown, and the nearby mountains and bays are visually stunning, but also reflect a complex ecosystem with multiple water sources home to many types of wildlife, including small mammals, birds and

◀ A feral pig, prevalent in certain regions of the central California coast. *G.W. Wiscomb*

◀ Feral swine tracks in a disked spinach field near a ranch. Fences cannot contain feral swine; they burrow underneath and move wherever they wish. *M.T. Jay*

feral swine, and small to large ranches with grass-fed cattle. These lovely sites may have unintended consequences for food safety.

Where are the pathogens?

Enteric pathogens, like *E. coli* O157:H7 and *Salmonella*, can colonize numerous warm-blooded animals and birds, which are then obvious potential reservoirs of pathogens and sources of contamination of produce. Surveillance studies of *E. coli* O157:H7 incidence in cattle, with improved methods of isolation and identification, yield frequencies in herds sometimes >50 %, but dynamic fluctuations in incidence at different locations or sample periods can occur also. Indeed, in the 2006 outbreak noted above, numerous cattle and feral swine colonized with the outbreak strain of *E. coli* O157:H7 were identified on ranch sites near to fields presumed to have been the source of contaminated spinach. Was this the 'smoking gun' explaining how the outbreak occurred, even though no pathogen could be isolated from fields and irrigation water during the investigation of the outbreak? Cattle had no direct access to the field, but signs of feral swine burrowing under fences and moving across fields, including faeces in disked fields, were documented, thus raising this as one theory about how the spinach became contaminated. Clearly, small animals can obtain access to almost any field or garden they desire to visit, but the incidence and/or amount of contamination in small animals is always difficult to assess. Nevertheless, a relatively high incidence of pathogenic bacteria in a group of animals, and high concentrations in faeces of even a few animals, could result in relatively rapid dissemination of pathogens in the environment, especially during heavy rain events with rapid water flows, dusty and windy conditions, or by other colonized creatures such as birds. Perhaps not surprisingly, *E. coli* O157:H7 has been detected frequently after heavy rains in watersheds that are near to produce fields and animal point sources, providing a potential link from point sources to watersheds and fields. But are there other, as yet unknown, transport processes involved in contaminating leafy vegetable or tomato plants and causing large and thus noticeable outbreaks? The answer is unknown, but studies are ongoing to address this issue.

How do enteric bacterial pathogens survive on plants in fields?

Outbreaks associated with pre-harvest-contaminated leafy vegetables confirm that enteric bacteria are capable of attaching somewhere on plants and remaining viable. Laboratory studies indicate that bacteria like *E. coli* O157:H7 and *Salmonella* applied to a variety of leafy vegetables or plant roots, leaves and seeds can attach tenaciously (resisting sanitizers) and survive, but also can grow under ideal conditions (warm temperature, high humidity, adequate nutrients). Sophisticated fluorescence microscopy reveals specific locations on leaves and roots where enough subcuticle cells and nutrients occur to provide a site for survival of opportunistic pathogen cells. Aggregation of pathogen cells with one another and with the natural plant microorganisms that they encounter suggests that active and complex interactions are involved over extended periods of time in the field, possibly leading to in-field contamination that is difficult to control.

Enteric human pathogens on plants in the field

Ideal conditions for human pathogen growth are not unexpected in the field, especially during summer/autumn growth cycles on the central coast of California. Field studies with non-pathogenic varieties of *E. coli* and other pathogens on plants under field conditions confirm that they can survive for weeks and months, depending upon the numbers of bacteria applied and the treatment conditions. However, even though surrogate pathogen cells in the soil or on plants seem to maintain their numbers for extended periods, significant growth of the pathogen has not been observed in these types of field studies. Factors in the field that can amplify the initial cell inoculum on plants at least 10-fold, as found in controlled lab studies, have yet to be identified. Possible factors worth considering and investigating are plant leaf micro-lesions caused by physical abrasions or insects, high temperatures, or other microorganisms (bacteria or fungi that attack plants), any of which could release nutrients for significant growth of enteric pathogens, like *E. coli* O157:H7 and *Salmonella*. Environmental reservoirs where significant growth of enteric pathogens outside warm-blooded animals could occur are potential outbreak-related risk factors. Are pathogens evolving increased fitness and virulence?

> *Fresh, minimally processed bagged leafy greens are here to stay, but consumer confidence must be re-established.*

The increased incidence of produce-related outbreaks traced to specific regions, and *E. coli* O157:H7 outbreaks in particular, has stimulated questions about what might have changed over the last decade to explain the situation. Is it related to growing (fertilization, water, shallow tilling, seeds, cultivars) or production practices (cutting, transport, bagging, atmosphere), changes in the pathogens (increased fitness in animals, water), livestock (transport, incidence of pathogens), or better detection (methods, public health system, media)? Any environment or intensive practice leading to significant replication of micro-organisms, including enteric pathogens, will increase the rates of new mutations, and increased 'fitness' in the environment(s) where the mutations are selected. Modern molecular biology techniques (genomics) are facilitating the fingerprinting of outbreak-related pathogen strains for the purposes of high-resolution tracking of the possible sources of contamination. Comparative genomics of these data yields insights about pathogen evolution and emergence of virulence-related factors. Although theories abound, no definitive conclusions are possible without more study and hard data from outbreak investigations.

The immediate future

Funding agencies and produce industries have recognized the importance of this issue to consumer confidence and have, therefore, funded many large and relevant projects to address the critical factors involved in these recurrent outbreaks. Many factors suspected of leading to the 2006 spinach outbreak will be studied, including wildlife involvement, environmental incidence, interventions, insect vectors, and water and compost quality. The very produce items that have caused specific concerns also are desirable for a healthy lifestyle. Buyers and processors are controlling the requirements for products, becoming stricter in setting the distance between livestock and produce fields, frequency of testing, flooding, wild animal visits, etc.

What's going on? Probably, a convergence of unusual events is required for very large outbreaks to occur, a factor everyone is hoping will not affect 2007 harvests. Logical theories about pre-harvest contamination provide points for study, but no definitive conclusion about the 2006 outbreak can be obtained. Fresh, minimally processed bagged leafy greens are here to stay, but consumer confidence must be re-established.

Robert E. Mandrell
Research Leader, Produce Safety and Microbiology Research Unit, United States Department of Agriculture, Agricultural Research Service, WRRC, 800 Buchanan Street, Albany, CA 94710, USA (t +1 510 559 5829; f +1 510 559 6165; e mandrell@pw.usda.gov)

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Rapid molecular detection of food- and water-borne diseases

Tiny cantilevers and lids can be used for the speedy detection of food- and water-borne pathogens. **Anja Boisen** and her colleagues believe the method will enable food and water quality control to move closer to the producer/supplier, so that any potential contamination can be discovered as fast as possible.

Micrometer-sized diving boards, also called cantilevers, can be used as highly sensitive biochemical sensors. The liquid to be analysed is passed through a pair of small cantilevers. Each cantilever has an integrated resistor with piezoresistive properties, which means that the resistance changes when the cantilever bends. Thus, by a simple electrical measurement of resistance change, the deflection of the cantilever can be determined. The measuring principle is shown schematically in Fig. 1.

One cantilever – the reference cantilever – is inert and is used to eliminate 'noise', such as temperature changes, in the system. The other cantilever is coated with a 'detector' layer that binds precisely the molecule to be detected. When the molecules land on the surface, the cantilever starts to bend due to changes in surface stress of the two faces of the cantilever. If the captured molecules, for example, tend to repel each other, the cantilever will bend downwards.

Small is good

The cantilevers can barely be seen with the naked eye. They are normally around 200 µm long, 40 µm wide and 1 µm thick, which compares with the 80 µm diameter of a human hair. The tiny size makes the cantilevers flexible and at the same time they have a high resonant frequency which makes them less sensitive to 'noise'. The cantilevers can detect deflections below 1 nm. Their small size makes a complete device with liquid handling and electronics possible in a few cm^2. Therefore, the measuring unit can be very compact and portable and suitable for 'point-of-use' analysis.

It is impossible to make advanced mechanical structures with micrometer dimensions and integrated electronics using fine mechanics. Instead, we use so-called photolithographic processes where the cantilevers are fabricated by etching a thin silicon wafer three-dimensionally. The procedure is relatively straightforward and is highly suitable for mass production. Therefore, it might be possible to make sensors so cheaply that they can be disposable. Fig. 2 shows an image of two silicon cantilevers.

Plastic is the future

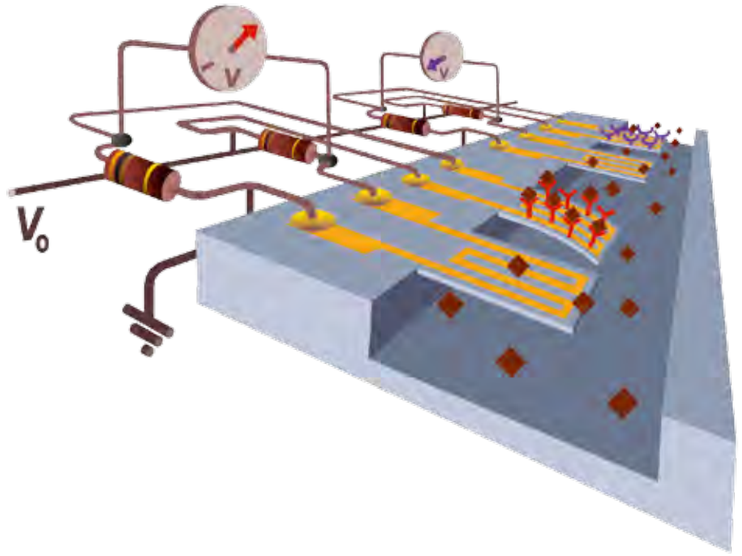
The cantilevers' sensitivity relies on their flexibility. Therefore, we have started to use polymers which are 40 times softer than silicon. In this way the sensitivity is immediately improved and the manufacturing cost is at the same time significantly reduced. The cantilevers are made by spin-coating the polymer onto a silicon carrier wafer. The polymer is structured by UV-lithography and by successive coating and structuring steps, cantilevers placed in micrometer-sized channels can be produced. An example of a polymer cantilever with an integrated gold resistor is shown in Fig. 3.

Catching bacteria

Whole bacteria or parts of bacteria can be caught directly on the cantilever. For example, if the cantilever is coated with antibodies against *Escherichia coli* it will specifically bind that organism and the cantilever will only bend if *E. coli* is present in the sample. The sensor can easily be expanded to contain several cantilevers, each coated with a specific 'detector' molecule. In this way it is possible to detect multiple bacteria simultaneously.

The cantilevers can also be used to recognize DNA. A single stand of DNA from *E. coli* is placed on a cantilever. A water or food sample can be treated relatively quickly so that the DNA from the bacteria is released and split into single strands. Next, the pretreated sample is sent to the cantilevers which will only react if the single-stranded DNA on the cantilever matches the

1



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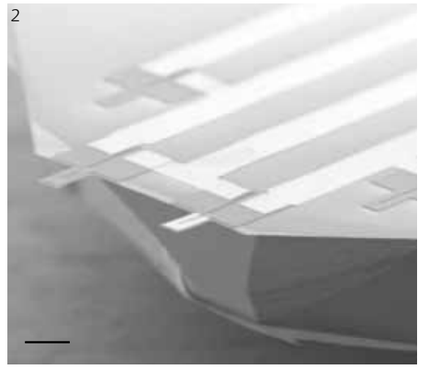

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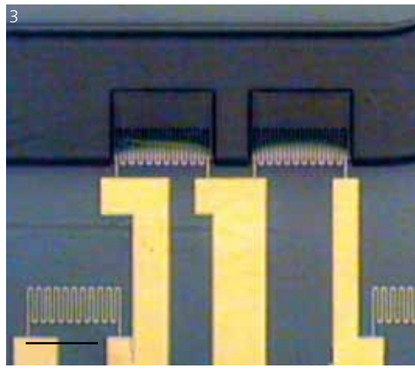

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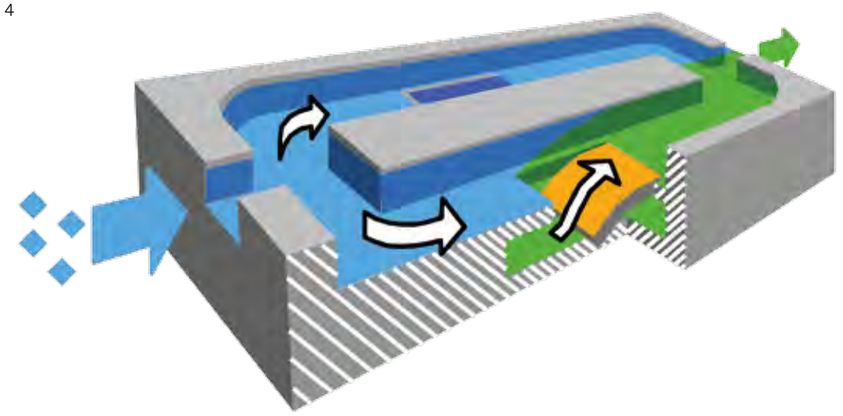
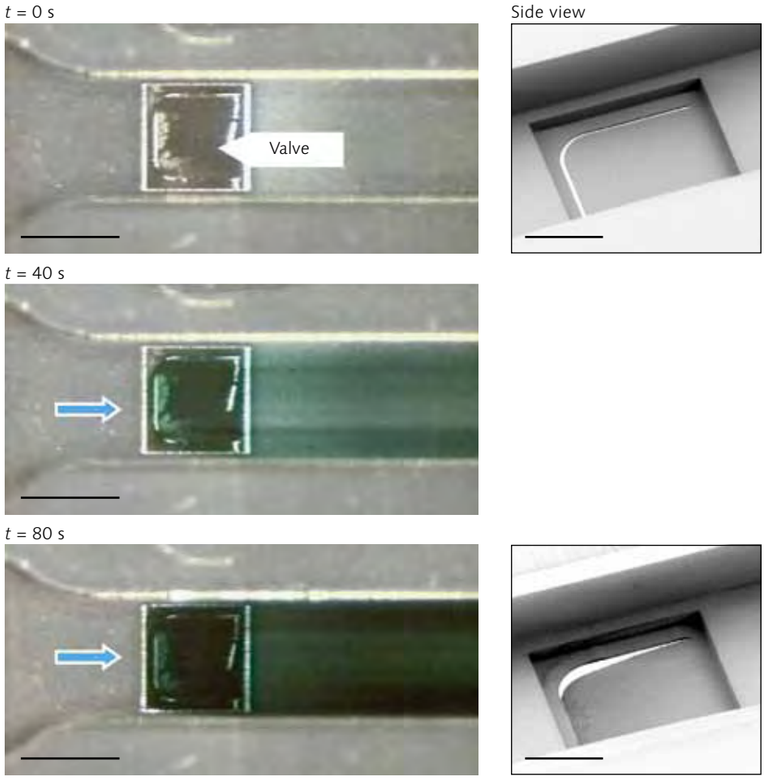


▲ Fig. 1. Schematic drawing of the cantilever measuring principle. When molecules attach to the cantilever, the cantilever bends and the bending is detected as a change in the resistance of the resistor placed inside the cantilever.

▲ Fig. 2. Image of two silicon cantilevers. One cantilever is coated with a thin layer of gold for the specific binding of molecules with a sulfur group at the end. Sulfur binds almost covalently to gold. Bar, 100 µm.

▲ Fig. 3. Image of a polymer cantilever with integrated gold resistors. Bar, 200 µm.

▲ Fig. 4. Schematic drawing of the operating principle of the 'lid' sensor. As molecules bind to the orange lid, the lid bends and releases the green colour.



◀ Fig. 5. Proof of principle of the 'lid' device. As a thin layer of aluminium is etched away from the lid's top surface, the lid starts to deflect and a green marker solution is released from the reservoir below the lid. Bars, 0.5 mm (main views), 200 µm (side views).

single-stranded DNA in the solution. If the cantilever bends, then *E. coli* is present in the sample.

The lid device

A new sensor principle, which we call the lid device, is illustrated in Fig. 4. Coloured marker molecules are loaded in a small container closed by a flexible lid. The lid is coated with specific detector molecules which bind the molecules under investigation. This binding causes the lid (just like a cantilever) to deflect, the marker molecules are released and they can be detected by the naked eye. The complete sensor is approximately 1×1 cm in size and is made of plastic. The deflection of the lid can also be caused by removal of a material on the upper surface of the lid. An example of the removal of a thin metal layer on the top of the lid and the subsequent colour change is shown in Fig. 5. The removal of material can be caused by bacterial activity (the bacteria 'eat' food on the lid) and the sensor can thus be used to monitor the presence/activity of bacteria.

The lid device is based on the release of a colour which can easily be detected by the eye following a specific reaction. This principle could be used in food diagnostics where there is a great need for cheap, disposable sensors. The sensor could be included in food packaging since it requires no external energy and is cheap to make. When a food is infected, the control unit in the plastic wrapping becomes coloured. Thus a simple colour indicator can show the quality of the food.

Only our imagination limits the future

There are many other possible applications for the technology. The detection of DNA can also be used to look for human gene-related diseases. For example, specific DNA sequences are known to be related to a larger risk of developing breast cancer. One can also imagine using the sensor in environmental control for monitoring the quality of drinking water. The cantilevers allow us to monitor the binding of molecules 'on-line' and it is therefore possible to follow bacteria-, enzyme-, DNA- and virus- binding processes in real time. Moreover, the lid device opens up the production of autonomous, disposable systems which enable the end-user to control water as well as food quality.

Anja Boisen, Stephan Keller, Maria Nordström, Alicia Johanson, Gabriela Blagoi, Mogens Havsteen Jakobsen & Daniel Haefliger
Department of Micro- and Nanotechnology, Technical University of Denmark, Kongens Lyngby, Denmark
(e ab@mic.dtu.dk)

microshorts

Lucy Goodchild takes a look at some stories that have hit the headlines recently.

Polio cheaper to eradicate

In 1988, 1,000 children were paralysed every day as a result of polio infection. Last year there were only 2,000 cases, thanks to the World Health Organization's $5 billion eradication programme. Public health experts are now advising against a further $1.5 billion expenditure to completely eradicate polio, as they believe it is too much to spend on a rare disease. However, a team of public health modellers has published a study in *The Lancet*, which shows that eradication would cost less than containment, even if it was to cost $8 billion. The results suggest that relaxing vaccination rates would cause infection rates to rise dramatically.

New Scientist, 21 April 2007, pp. 6–7

Microbes produce plastic they can feast on

The US company Metabolix has created a starch-based plastic, Mirel, which can biodegrade in soil, wetlands and even oceans. Today's most common plastic is polylactic acid, or PLA, which is not biodegradable and cannot withstand high temperatures. Mirel is polyhydroxyalkanoate, or PHA, which can resist temperatures of up to 140 °C and can be formed into soft, flexible film or hard, crystalline solid. It is produced by genetically modified bacteria; the microbes are fed glucose made from corn starch. Many micro-organisms also feed on PHA, so any product made from Mirel can be broken down in most environments. The products will be available next year.

New Scientist, 28 April 2007, p. 4

Is there life on Mars?

In 2003, methane was discovered on Mars. Now, scientists at NASA Goddard Space Flight Center are taking another look at the original findings of three research teams to determine its concentration. Although it seems that methane is only present in small quantities, the presence alone is a significant indicator of biological activity. Its origin could be geological (by serpanitization, a process similar to that seen in terrestrial black smokers) or biological (via the Martian equivalent of methanogenic bacteria), both equally plausible explanations. On Earth, 90–95 % of the atmospheric methane is of biological origin, with volcanoes contributing less than 0.2 %, a scenario that is possible on Mars.

The next step is to determine the carbon isotope ratio of the planet; if there is a large amount of carbon-12 compared to carbon-13, the methane is likely to be of biological origin. Similar data taken from studies of the atmosphere of Titan (one of Saturn's moons) have shown that the planet's standard carbon isotope ratio value is 82.3, which is smaller than that of the Earth and therefore supports the biological hypothesis. Overall, however, the massive quantity of methane on Titan is less likely to be of biological origin.

Scientific American, May 07, pp. 24–33


Comstock / Jupiter Images

Could *Helicobacter pylori* protect against asthma?

Researchers at NYU School of Medicine examined data from the Third National Health Nutrition Examination Survey, which was conducted from 1988 to 1994. The survey included questions about participants' history of asthma, allergic rhinitis and allergies. 7,663 adults were also tested for antibodies to *H. pylori*. The data showed that people infected with a more virulent strain of the bacterium were 20 % less likely to have ever had asthma (and 40 % less likely to have had it at an early age) than those who were not. Results of allergy skin testing also suggested that *H. pylori* infection may protect against sensitivity to certain allergens, like pollen and mould. Results support the hygiene hypothesis, which suggests that exposure to antigens in early childhood prevents the development of allergies. *H. pylori* has become a less prevalent pathogen, partly due to widespread use of antibiotics, which could explain the increase in asthma sufferers.

www.ebiologynews.com/1700.html


Goodshoot / Jupiter Images

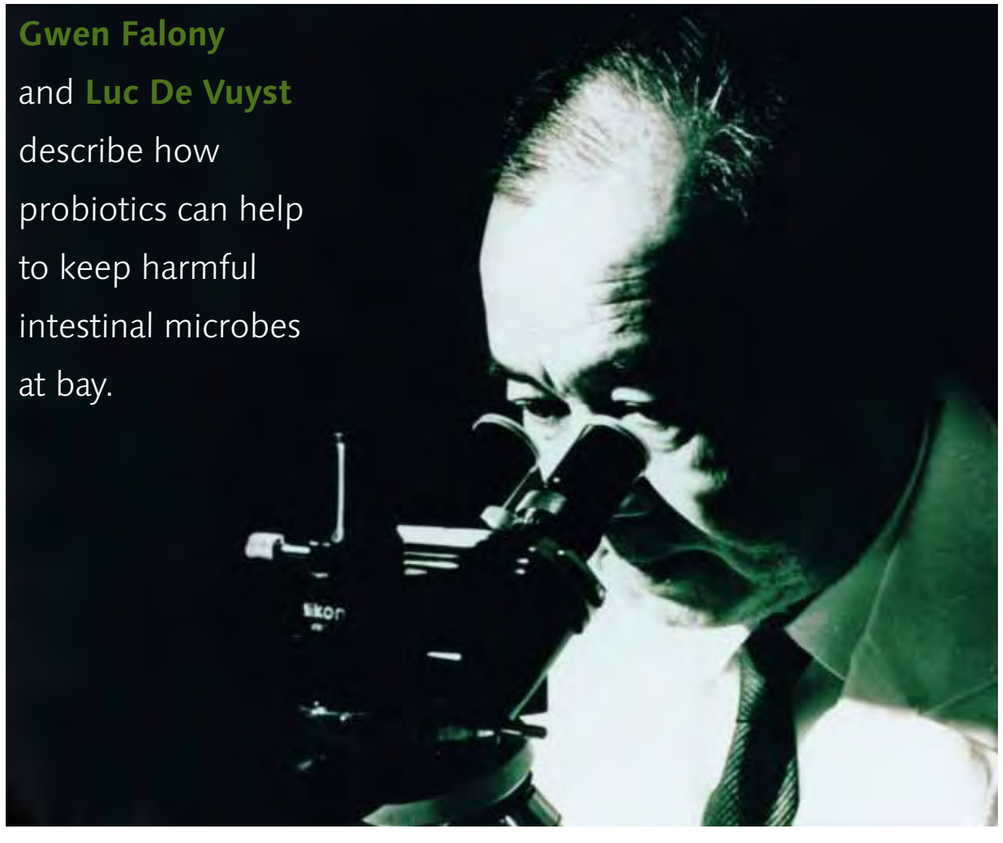
Marine microbes make climate-changing gas

Dimethyl sulfide (DMS), the chemical that makes the seaside smell like, well, the seaside, is produced by marine microbes, according to researchers at the University of East Anglia. A gene in the marine bacterium *Marinomonas* has been identified that scientists believe is responsible for the ability to convert dimethyl-sulfonipropionate, produced by phytoplankton, to DMS. The gene, *dddD*, has also been found in the Sargasso Sea metagenome, which represents over 1,800 bacterial species that inhabit the North Atlantic. DMS stimulates the formation of clouds that prevent sunlight from reaching the earth's surface, and therefore the gas has a major effect on climate change.

Planet Earth, Spring 2007, p.7

Probiotics: weapons in the war against gut pathogens

Gwen Falony and **Luc De Vuyst** describe how probiotics can help to keep harmful intestinal microbes at bay.



The human gut contains huge numbers of bacteria, more than 10,000 times the world's human population, which closely interact with our bodily functions. Some of these interactions are considered to be beneficial and others neutral, while certain colon inhabitants are pathogens and can threaten our health. In healthy people, the whole of the bacterial gut community forms a balanced microbiota of more than 500 species that actually contributes significantly to the body's resistance to occasional infections, such as gastrointestinal diseases caused by food-borne pathogens. Changes in the composition of the gut microbiota may disrupt that balance and leave the host more vulnerable to infections, or, in some cases such as gastrointestinal infections and food allergies, even be the cause of diseases.

Probiotics

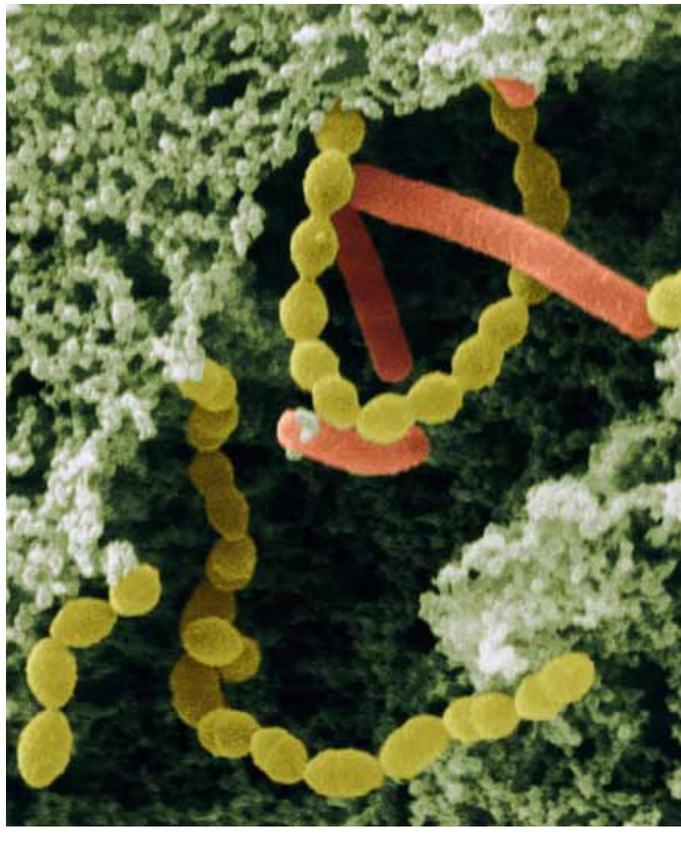
Nowadays, consumers are aware of the role of the gut microbiota in health and disease. They understand the necessity to maintain their health through appropriate nutrition. The belief that specific foods provide protective functions has been long held by populations that ate fermented foods, such as yoghurt, koumiss and fermented cabbage. Such gut protection is determined by living bacteria and their metabolic products. This knowledge has opened the market for the concept of 'probiotics' – the word stems from the Greek προ βιος (*pro bios*, 'for life') – a term traditionally used to describe the use of live micro-organisms as food supplements that benefit the host by improving its intestinal microbial balance (Table 1). In 2001, a joint FAO/WHO expert committee proposed defining probiotics as 'live micro-organisms that, when consumed in an adequate amount as part of the food, confer a health benefit on the host', an enlarged definition that is still commonly used today.

Certain strains of lactic acid bacteria, such as lactobacilli, and bifidobacteria are the most common micro-organisms used as probiotics. As the name suggests, lactic acid bacteria produce lactic acid through sugar fermentation. They have been used for centuries to produce fermented foods. Probiotics are available as fermented and non-fermented foods (probiotic foods), and as food supplements. Some probiotics are now used as an alternative therapy for treatment of infectious gastroenteritis, or in the prevention and cure of antibiotic-associated diarrhoea. Further exploitation of the prophylactic potential of probiotic micro-organisms is very promising with respect to the development of new and progressive disease control strategies.

A concise history of probiotics

A beneficial association of micro-organisms with the human host was probably first suggested by Albert Döderlein in 1892. He found that vaginal bacteria producing lactic acid prevented or inhibited the growth of pathogenic bacteria. Later, in 1906, the Frenchman Henry Tissier reported clinical benefits from modulating the gut microbiota in infants with intestinal infections by the displacement of the pathogenic bacteria with bifidobacteria. In 1908, in *The Prolongation of Life*, the Russian Nobel prizewinner Elias Metchnikoff, who was then working in the laboratories of the Institut Pasteur in Paris, hypothesized for the first time the importance of lactobacilli to human health and longevity. Although he considered the gut microbiota in total as detrimental rather than beneficial to health, he suggested that desirable effects might be expected only from their substitution by yoghurt bacteria. In this context, Metchnikoff actually promoted lactobacilli for their major metabolite of sugar fermentation, namely lactic acid. In the early 1920s Rettger and Cheplin documented that acidophilus milk displays therapeutic effects. They believed that colonization

◀ Dr Minoru Shirota who, in 1930, was the first to bring a strain of 'good' intestinal bacteria into culture for manufacturing a dairy drink. *Yakult Belgium NV*



▼ Colour-enhanced scanning electron micrograph of the yoghurt bacteria *Streptococcus thermophilus* (yellow cocci) and *Lactobacillus delbrueckii* subsp. *bulgaricus* (red rods) bacteria in yogurt. *SCIMAT / Science Photo Library*

and growth in the gut of the microbes involved were essential for efficacy and, therefore, they advocated the use of intestinal isolates. Finally, in 1930, Dr Minoru Shirota in Japan was the first to bring a strain of 'good' intestinal bacteria into culture for manufacturing a dairy drink, named Yakult. Nowadays, there are several other probiotics and probiotic foods on the market.

Gastrointestinal infections: hurdles to cross

As the human gut is an open system, it is continuously exposed to the threat of being colonized by potentially pathogenic micro-organisms. It has therefore developed an efficient host defence system, promoted by the proper and/or synergistic functioning of the gastrointestinal epithelium and the resident gut microbiota. These two partners form a physical, chemical and microbial barrier in our gut against microbial pathogens. To cause disease, a possible pathogen has to overcome a series of hurdles. The first hurdle consists of adhesion of the pathogenic cells to the host's intestinal epithelium. This first step is essential; otherwise the pathogen is flushed out by the fluid flow in the gut lumen and by peristalsis. Once bound, the pathogen can start to colonize the epithelial surface. Therefore, it must resist the environmental conditions in the gut, created both by the host that will counterattack via the immune system, and by the other microbes present in the intestine, an interaction also referred to as colonization resistance (barrier effect). This is the phenomenon by which microbes already present in the gut display properties (competitive and antagonistic) that prevent or minimize the growth of newly introduced strains reaching the colon in the flow of partially digested food ingredients. Only after crossing these hurdles can a pathogen start to induce harmful effects in the intestines, such as disruption of the tight junctions of the epithelial cells by production of enterotoxins and by inciting inflammation of the gastrointestinal mucosa.

Probiotic actions against pathogens: mobilizing defences

Probiotics are thought to be able to strengthen every line of our colonic defences against invasion by pathogens, thus contributing to human health. First, pathogens and probiotics have to compete against each other for the nutrients available in the gut lumen. Given the complex, nutrient-rich environment of the gut ecosystem, this might not be the limiting factor for pathogen proliferation. Additionally, however, pathogens and probiotics compete for colonization sites. Some probiotics may gain an advantage in this competition for host binding sites by secreting anti-adhesive molecules, or by inciting the host to enhance mucus production.

On a second level, probiotics can directly interfere with growth and even kill pathogens by producing antimicrobial compounds. Weak organic acids, such as lactic acid and acetic acid, the main metabolic end-products of the carbohydrate metabolism of probiotic lactic acid bacteria and bifidobacteria, have strong antibacterial activity. These acids can permeate into bacterial cells and disturb key biochemical processes by lowering intracellular pH. Furthermore, they can make bacteria more vulnerable to the actions of other specific substances, such as antibacterial peptides. This may explain why a large number of *Lactobacillus* strains inhibit the growth of bacterial pathogens, such as the gastric pathogen *Helicobacter pylori*, and food-borne pathogens, such as *Campylobacter*, *Salmonella*, *Escherichia coli* and *Listeria monocytogenes*.

Third, probiotics may have an influence on the immune system of the host. They can stimulate the innate (e.g. enhanced production of defensins) as well as the adaptive immune response. Concerning the latter, some probiotics seem to direct host responses to an inflammatory, cellular reaction, where others enhance the antigen-mediated response. This should be taken into account when selecting a probiotic to treat a particular infection. Moreover, the effect of probiotics on the human immune system stretches beyond the gut and can have an influence on the body's defence towards a large variety of infections.

Specialized forces

Besides these specific targets of action, probiotic strains differ with respect to their health-promoting effects. Therefore, the consumer should be aware of two very important issues. First, health-promoting effects are strain-dependent. This means that not all strains of a given species possess the health-promoting properties of a probiotic strain of that species. One can compare this with the human capacity to speak more than five languages, to play sports in a high level competition, to climb a mountain, etc., which is individual-dependent, although we all belong to the same human species. Moreover, it is obvious that not all probiotic strains possess all health-promoting properties mentioned above. Unfortunately, food manufacturers sometimes misuse the probiotic concept by not specifying the probiotic strain used and extrapolate the health-promoting properties of certain probiotic strains to all strains of that species. As a result strain identification and scientific validation of the health-promoting effects of the strains used are absolutely necessary and should be communicated to the consumer through clear food labelling and freely accessible, easy-to-understand documentation.

Second, health-promoting properties of valid probiotic strains are matrix-dependent. Efficacy of a probiotic strain in a certain food matrix, for instance milk, is not necessarily the same in a cereal or meat matrix. Even within a milk matrix, efficacy will be dependent on the texture of the matrix, which is different in, for instance, milk, yoghurt and fresh cheese. Moreover, the quantity of cells to be added to the product by the food manufacturer and the amount of food product to be taken up by the consumer are dependent on the food matrix. It is clear that appropriate and well designed, well conducted, experiments *in vitro* (laboratory) and *in vivo* (mice and human intervention trials) studies are necessary to relate certain factors to the effectiveness of probiotic strains and probiotic foods.

Table 1. A few examples of the changing definitions of probiotics

Year	Author	Definition
1970s	Sperti	Tissue extracts that stimulate microbial growth
1974	Parker	First use of the term 'probiotic'. Animal feed supplements (organisms and substances) that have a beneficial effect on the animal host by contributing to its intestinal microbial balance
1989	Fuller	Live, microbial feed supplements that beneficially affect the host animal by improving its intestinal microbial balance
1990s	Several authors	Definitions that focus on viable micro-organisms (lactic acid bacteria and other bacteria and yeasts), animal and human hosts, living cells applied in a fermented product or as dried cells, mixtures of cultures, and health benefits beyond equilibration of the indigenous microbiota.
2001	FAO/WHO	Live micro-organisms that, when consumed in an adequate amount as part of the food, confer a health benefit on the host.
2002	ILSI	Live, microbial food ingredient that, when taken up in adequate amounts, confers health benefits on the consumer.
2003	EFFCA	Live micro-organisms, which, when ingested or locally applied in sufficient numbers, provide the consumer with one or more proven health benefits.

Probiotics are thought to be able to strengthen every line of our colonic defences against invasion by pathogens.

▶ Probiotic fermented milks are produced in huge fermentation vessels and sold as ready-to-consume small bottle portions. *Yakult Belgium NV*

Luc De Vuyst
Professor of Industrial Microbiology and Head of the Research Group of Industrial Microbiology and Food Biotechnology, Vrije Universiteit Brussel, Brussels, Belgium (e ldvuyst@vub.ac.be)

Gwen Falony
PhD student working on the mechanisms of cross-feeding between bifidobacteria and other colon bacteria.

Further reading

De Preter, V. & others (2006). Effects of *Lactobacillus casei* Shirota, *Bifidobacterium breve*, and oligofructose-enriched inulin on the colonic nitrogen-protein metabolism in healthy human subjects. *Am J Physiol Gastrointest Liver Physiol* **292**, G358–G368.

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How can modern science help in the fight against the hidden microbial foes in our water supply? Water expert **Joan B. Rose** describes the issues and some of the solutions to the problem.

Science in the fight against water-borne disease

I am a water pollution microbiologist and I follow the microbes in faeces, from the septic tank to the beach, from the sewage to the river, from the manure to the well, from the irrigation waters to the vegetables, from the toilet to our hands. People and animals, even birds, deposit faecal microbes into the environment and many of them are infamous stealth agents, hidden and dangerous, secretly spreading disease through one of our most precious resources, water.

These microbes, bacteria, parasites and viruses, can be transmitted via contaminated water, food or through the surfaces we touch and our hands. They were designed to be excreted in high numbers by infected individuals, survive in the environment and be spread through ingestion. Table 1 provides a glimpse of some of these infamous water-borne pathogens. But new emerging microbes are also being discovered in sewage, including the ulcer-causing bacterium *Helicobacter* and cancer-causing polyomaviruses, and our investigations into their 'potential' for causing water-borne disease have just begun.

CSI for water (the case of the missing scientific data)

I heard once at a meeting that 'safe water' meant to a community what a 'safe blood supply' meant to medicine. Thus protecting the supply and vigilant monitoring are necessary to provide adequate life-saving water when and where we need it. Protection from disease-causing agents and pathogen discovery is one of the most important areas of study in the fight against water-borne disease. To really address how we can stop contamination and spread of disease to our communities through water we must first understand:

> the sources of these pathogens;
> their concentration in waste and water;
> their survival in the environment;
> their ability to be transported from the source to the exposure site;
> their ability to resist drinking water and wastewater treatment;
> their ability to cause harm.

Those of us undertaking such investigations have powerful new tools to assist in providing scientific data for each of the issues above. An example of such a tool is the polymerase chain reaction (PCR) – this can be used for source tracking, to identify virulence markers and to identify pathogens. By using these tools, the culprit can be found and the water-borne 'crime' can be solved. Yet investment in strategic/investigative monitoring is rarely made, thus we are left with many unsolved water-borne outbreaks and no scientific data to assist in preventing the next one.

Google water?

We have arrived, we made it to the 21st century. Information is plentiful, at the touch of a computer button we can gain access to all types of facts and figures. But, if you 'Google' *water*, you get 576,000,000 hits, including the US Environmental Protection Agency (EPA) website, the Power of Water, World Water Day, and Bottled Water. If you Google *water quality*, you get 167,000,000 hits; if you Google *water-borne disease*, you get 965,000 items, including the Centers for Disease Control (CDC) and World Heath Organization (WHO) websites. If you Google *water-borne disease maps* (you get one for US and one for Canada), you can find maps from the WHO from various countries: Zambia and cholera for example (www.reliefweb.int). Thus surveillance has improved – information is being formatted and disseminated. However, information is not necessarily knowledge. Our molecular tools have to be used within a framework which can aid decision-making, better strategic monitoring and communication.

The relationship between our health and water quality is also connected to quantity, precipitation, flooding, extreme events and land use. These interconnections must be thoroughly studied and tied into a risk-based framework which can be fed into Water Safety Plans (WSP) and Hazard Analysis and Critical Control Point (HACCP) strategies to protect the watershed and to address adequate treatment. Finally, we should all begin to think about our water ethics philosophy, from global agencies through government departments to local water authorities. Water-borne diseases are the plane crashes in a community and remain a significant threat to global health, particularly for the disadvantaged and our sensitive populations.

We have the scientific tools, and with the political support we could eradicate typhoid and cholera, those ancient diseases that still plague our world, and we can track down any newly emerging pathogen and learn what we need to do to both protect and respond to water contamination. In this century, those of us in the water pollution microbiology field can really begin to work toward stopping the faecal contamination of our waterways.

Joan B. Rose
Homer Nowlin Professor of Water Research, Michigan State University, 13 Natural Resources, E. Lansing, MI 48824, USA (e rosejo@msu.edu)

Table 1. Ancient and modern infamous agents of water-borne disease

Microbe	Description	Famous for:	Current issues
Vibrio cholerae	Bacterium which causes cholera. No animals carry this bacterium but it can live in the marine environment.	Epidemics in London (Broad Street Pump); spread throughout the world with the first pandemic in 1817. Spread to every country in South America in one year, during 1990, the seventh pandemic.	Remains one of the most serious water-borne diseases in the world with a reported 100,000–250,000 cases per year with about 2,000–3,000 deaths (www.who.int/wer/2005/wer8031.pdf).
Salmonella typhi	Bacterium which causes typhoid. Comes from humans, highly tied to poor sanitation.	Plague of Athens. Epidemics during early settlements throughout history (London, India, Jamestown, Chicago).	The current disease burden of typhoid is estimated at 17 million cases per year and 600,000 deaths (www.who.int/vaccine_research/ diseases/typhoid/en/)
Escherichia coli O157:H7	Bacterium which causes haemolytic uraemic syndrome. Particularly associated with cattle and manure.	Outbreaks in swimming pools, during fairs from wells, from burgers and spinach. Famous for its ability to cause death in the young and old, affecting the kidney with some children needing kidney transplants.	Untreated animal manure and impact on untreated waters, including wells, irrigation water and recreational rivers and lakes.
Cryptosporidium hominus and *C. parvum*	Parasitic protozoa that cause severe diarrhoea; one type comes from humans, one from animals (e.g. cattle and sheep)	Causing the largest water park and drinking water outbreaks in recent times. Famous for being resistant to chlorine disinfection. Deadly to those with AIDS.	Widespread global pathogen, common in humans and animals. Increase in AIDS infections throughout the world suggests high vulnerability to disease with potential death.
Norovirus	Virus causing a rapid and violent vomiting and diarrhoeal illness. Comes from humans and survives on surfaces.	Cruise-ship vomiting disease. In the last year a new strain causing unprecedented outbreaks worldwide has appeared.	New strains developing rapidly; survives in water and on surfaces, and is difficult to clean up.

◀ *IT Stock / Jupiter Images*

The aesthetic microbe: ProkaryArt and EukaryArt

Simon Park takes inspiration from the beauty of micro-organisms and shows how they can be used to bridge the divide between art and science.

It is a delightful paradox that the normally invisible has an enduring influence on what can be our most profound visual experiences. In this context, the effect of microbes on the visual arts is antithetic in that their activities provide inspiration for the artist, yet they are also capable of destroying some of our most important artistic heritage. Whilst any painting is potentially at risk, perhaps the most poignant example of this is the microbial destruction of the Lascaux Cave paintings, which date back to 15,000 BC and are some of humanity's earliest forays into art.

Long before their empirical revelation, microbes influenced the sensibility of many artists, perhaps most notably in Nicolas Poussin's *The Plague at Ashdod* and Raphael's *Il Morbetto*. Then as the microscope began to reveal a previously hidden world, artists and scientists alike were quick to appreciate that microbiology is also able to produce depictions of great beauty. Indeed, in some of the earliest representations of micro-organisms it is often difficult to differentiate between technical representation and art. The aesthetic nature of microbes can be readily seen in Hooke's *Micrographia*, Sergei Winogradsky's hand-coloured drawings from *Microbiologie du Sol*, Henriëtte Beijerinck's paintings, and Ernst Haeckel's *Kunstformen der Natur*. Micro-organisms have also featured in more obvious examples of art, for instance in Hieronymus Bosch's *Garden of Earthly Delights*, in which there appear to be representations of at least 22 species of slime moulds.

Today, at a time when many micro-organisms have been rendered into the very still life of a DNA genome sequence on a computer screen, our over-familiarity with the microscopic life forms means that the aesthetic nature of microbiology is often overlooked. However, cross-disciplinary projects involving scientists and artists are becoming increasingly common and the microbe is being reinvigorated as an art form. Artists are now beginning, with some understanding of the science, to exploit the vast conceptual palette that microbiology offers, and in a manner that seeks to blur boundaries between art and science. We are approaching an artistic microbiological renaissance, where the microbe is taking centre stage, and starring in forms of art where the medium is living matter itself.

▶ Fig. 1. Sample images from *Microcosmos*, an audio/visual installation that resulted from a collaboration between myself, Pattie Hendrie, BBC cameraman Steve Downer and composer Milton Mermikides from the Royal Academy of Music that explores the often unappreciated beauty and significance of bacterial colonies. (a, b) *Vogesella indigofera*; (c) *Pseudomonas aeruginosa*. *S. Park*

▶ Fig. 2. *The Bacteria Art Exhibition* – some examples of Eshel Ben-Jacob's work with *Paenibacillus* colonies. © *Eshel Ben-Jacob*

▶ Fig. 3 (opposite). *Mushroom Circle* – one of a number of artworks by land artist Chris Drury in which the nucleus of a fungal spore print is surrounded by minutely inscribed names that echo the patterns formed from the deposited spores. © *Chris Drury*

As I recently discovered for myself, even the apparently mundane can have artistic potential. Given time, and if allowed to grow beyond the standard overnight incubation, bacterial colonies can develop into some remarkably beautiful structures. The images shown in Fig. 1 formed the basis of *Microcosmos*, an audio/video installation that presents these images together with a soundscape derived from the DNA sequences of bacteria. Eshel Ben-Jacob has also found artistic potential in colonies, but in this instance, in the striking organization of the colonial forms of *Paenibacillus dendritiformis* (Fig. 2). Both of these examples, which could be considered to be ProkaryArt, are visually appealing, yet they also carry a scientific message that reflects the nature of bacterial growth, pigment and antibiotic production, and the underlying social intelligence of bacteria. Of course, artists may choose to practice EukaryArt and land artist Chris Drury has produced some striking works based on fungal spore prints (Fig. 3).

The often unappreciated microbiology of the familiar has also provided inspiration for several modern artists. Anna Dumitriu has used the qualities


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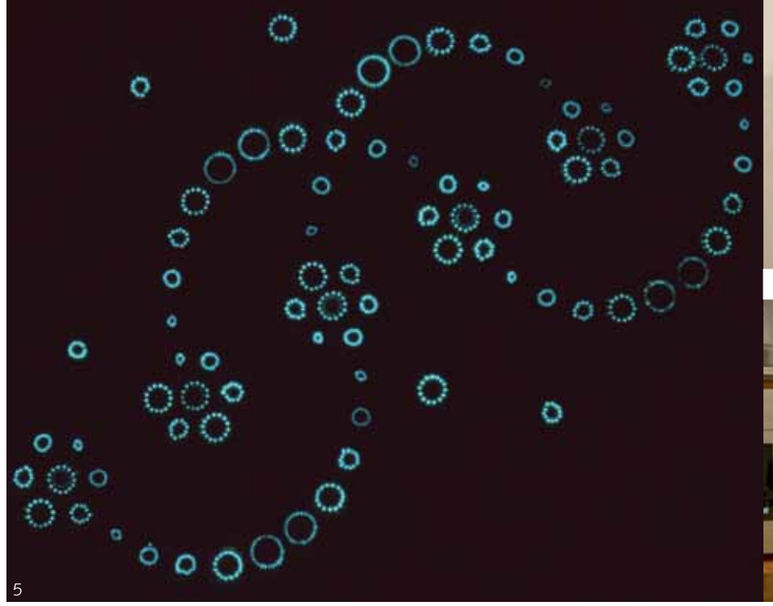
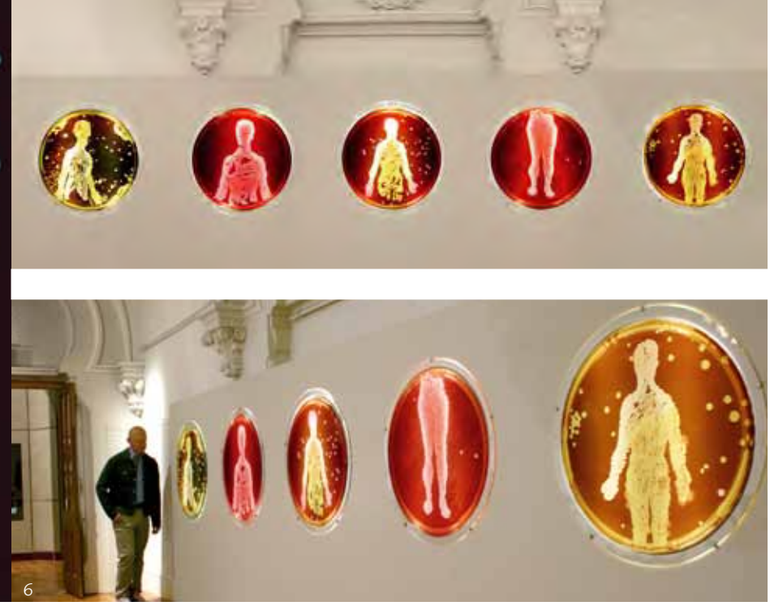
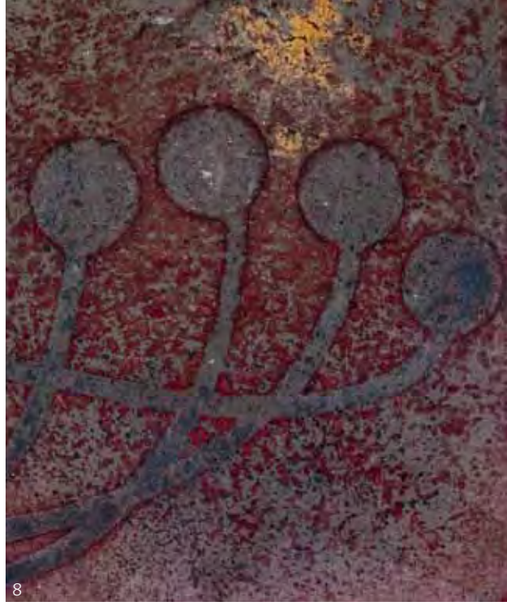






▲ Fig. 4. *Cutlery flora*. Artist Anna Dumitriu collaborated with Dr John Paul to explore the normal flora of household objects. Here a microscopic image of the normal flora of a cutlery set has been etched onto it.

▲ Fig. 5. An example from the *Bioglyphs* project, in which members of the Center for Biofilm Engineering and the Montana State University School of Art used bioluminescent bacteria to generate art forms. © *MSU-Bozeman Bioglyphs Project 2002*

► Fig. 6 (opposite). Peta Clancy's *Visible Human Bodies* exhibition. © *Peta Clancy – courtesy thirtyseven° Contemporary Fine Art Gallery, Sydney, Australia*

► Fig. 7. A sample image from *Sixty Days Goodbye Poems Of Ophelia*, a Wellcome Trust SciArt-funded project between myself, JoWonder, Steve Goss and Milton Mermikides (composers), and Steve Downer (cameraman) which will create a living interpretation of John Everett Millais' painting *Ophelia* using pigmented bacteria. © *JoWonder*

► Fig. 8 (opposite). *Clairvoyance*. An example of a 'biotope' from Eduardo Kac's *Specimen of Secrecy about Marvelous Discoveries*, a series of works of visually striking, self-sustaining microbial ecologies that change in response to environmental conditions. © *Eduardo Kac*

of the normal microflora of common objects as the basis of a number of artworks ranging from mobile phone wallpapers, to household objects onto which microscopic images of their microflora has been transposed (Fig. 4). Polona Tratnik has explored a similar theme, but through a more direct approach in which the growth of the normal flora *in situ* on household objects provided the basis for her artistic inspiration. An intriguing variation of this theme is Peter Germin Hoffmann's *Mikroben bei Kandinsky*, in which the microflora of a Wassily Kandinsky painting was exhibited as a finished artwork.

BioArt

One of the most challenging areas of art involving micro-organisms is BioArt, in which the medium used by the artist is living biological matter. Alexander Fleming was amongst the first to recognize the potential of microbes in this context when he famously made use of coloured bacterial colonies in his 'germ paintings'. Modern variations of this concept include the *Bioglyphs* project in which bioluminescent bacteria form the basis of some enthralling artworks (Fig. 5), and Peta Clancy's *Visible Human Bodies* (Fig. 6), which consist of images of bodies made from bacteria grown in Petri dishes. My own foray into BioArt is a Wellcome Trust-funded collaboration between myself and artist JoWonder, the aim of which is to create a living and contemporary interpretation of John Everett Millais's painting *Ophelia* using pigmented bacteria as the medium. The project is still ongoing but its potential can hopefully be seen in Fig. 7.

Most recently BioArt has shown the capacity to incorporate and communicate some of the complexity of modern microbiology. Eduardo Kac's work *Genesis* operates in this context as it involved the insertion of a synthetic gene sequence, derived from a sentence from the bible, into *E. coli*. *Specimen of Secrecy about Marvellous Discoveries*, another of his works, is a series of visually striking, self-sustaining microbiological ecologies (Fig. 8), that, like Winogradsky columns in the laboratory, reveal the hidden complexity of the microbial world, but in an art gallery. Jenifer Wightman has also explored this concept in an interpretation of Mark Rothko's paintings using bacterial ecologies. Other examples of this genre include: bioluminescent furniture and glass vessels; Steven Wilson's interactive microscope installations in which humans can compete with protozoa or interact with their own microflora; a signature of human intelligence that has been embedded into the genome of *Bacillus subtilis*; an audio microscope; pictures made from *E. coli* expressing green fluorescent protein; and Adam Zaretsky's *E. coli* which were monitored, not surprisingly, for signs of stress after being exposed to Engelbert Humperdincks's *Greatest Hits* for 48 hours!

I should add a brief note of caution at this point in case any non-microbiologist reading this article should be inspired to practice BioArt. The use of microbes in art is not without risks to the artist. Steve Kurtz, an associate professor of art at the University at Buffalo, but not a microbiologist, is also a practitioner of ProkaryArt. He first came to the attention of the police in May 2004, not because of this, but when he reported the death of his wife due to heart failure. Investigators coincidently discovered some of the mostly harmless biological specimens that he used for his work in the house, and whilst he never intended to cause harm with the bacteria, this did not prevent the FBI from detaining him under terrorism legislation. He now faces 20 years in prison for fraudulently obtaining bacterial cultures.

Hopefully, the examples in this article demonstrate the ways in which artists, perhaps for the first time, are embracing the true artistic potential of the microbe. Whilst their works are not intended to provide a rational understanding of microbiology, their art has become an important forum that can communicate, on an intuitive level, the sublime nature of the microbial world. In his philosophical *Enquiry*, Edmund Burke relates terror, obscurity and infinity to the aesthetic experience when he states that '*the passion caused by the great and sublime in nature, when those causes operate most powerfully, is astonishment; and astonishment is that state of the soul, in which all its motions are suspended, with some degree of horror*'. For artists who seek to reflect the sublime in their work, surely there is no better conceptual palette in nature than the microbe.

Simon Park
School of Biomedical and Molecular Sciences, University of Surrey, Guildford, Surrey GU2 7XH
(e s.park@surrey.ac.uk)

The author would like to thank the Wellcome Trust for funding and Anna Dumitriu for discussions on the sublime.

Websites

Henriëtte Beijerinck paintings – www.bt.tudelft.nl/live/pagina.jsp?id=32be4f0b-1d69-4d6a-afdb-ac2984457da0&lang=en

Eshel Ben-Jacob images of filamentous bacterial colonies– http://star.tau.ac.il/~eshel/gallery.html

Bioglyphs project – www.erc.montana.edu/Bioglyphs/default.htm

André Brodyk – www.ccc.newcastle.edu.au/profiles/andrebrodyk/index.html

Peta Clancy's *Visible Human Bodies* – www.petaclancy.com/

Joe Davies – www.viewingspace.com/genetics_culture/pages_genetics_culture/gc_w03/davis_joe.htm

Chris Drury – www.chrisdrury.co.uk/

Anna Dumitriu's *Normal Flora* project – http://web.mac.com/annadumitriu/iWeb/NF/Home.html

Fleming's germ paintings – www.ingenious.org.uk/see/Scienceandtechnology/Biologyandbiotechnology/?target=SeeMedium&ObjectID=%7B8BD5DB43-88B4-1614-E952-09373D9AB461%7D&s=S1&viewby=images&

Eduardo Kac's *Specimen of Secrecy about Marvelous Discoveries* – www.ekac.org

Polona Tratnik's *Microcosmos* – www.ars-tratnik.si/Microcosmos.htm

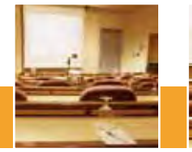
Symbiotic Bacterial Light project – www.fusionmedia.net.au/sblp/luxcorp.html

Wellcome Trust Art Awards,promoting collaborations between artists and scientists – www.wellcome.ac.uk/node2580.html

Steven Wilson's interactive microbiological installations – http://userwww.sfsu.edu/~swilson/

JoWonder – www.jowonder.com/

meetings



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*Please note: to qualify for earlybird rates, 2007 membership fees must be paid by 3 August.

Postgraduate Conference Grants

For full details, a form and allowances for travel see **www.sgm.ac.uk/grants/pg.cfm**

Offered Poster Presentations

Delegates whose offered posters have been accepted should note that an area of 90×90 cm only is available on the poster boards for their display.

Microscene Noticeboard

At the meeting, a board will be set up with notices of jobs, postdoctoral positions, studentships, courses, conferences etc. Contributions are welcome and may be either brought to the meeting or sent beforehand to Janet Hurst (**e** j.hurst@sgm.ac.uk).

Special Events

Monday 3 September
Welcome Reception
Get to know your fellow delegates over a glass of wine on the first evening of the conference. Venue: Appleton Tower, George Square.

Tuesday 4 September
Society Dinner
A four-course meal with inclusive wine and pre-dinner drink will take place at the Playfair Library.

Irish**Branch**

Microbial functions in response to the environment

Queen's University of Belfast
30–31 August 2007
Organizer John McGrath

Regulatory mechanisms in host–pathogen interactions

National University of Ireland, Galway
27–28 March 2008
Organizer Conor O'Byrne

For details of Irish Branch activities contact Evelyn Doyle (e evelyn.doyle@ucd.ie).

Meetings on the web

For up-to-date information on future Society meetings and to book online see **www.sgm.ac.uk**

Meetings organization

The SGM meetings programmes are organized by the committees of the special interest groups, co-ordinated by the Scientific Meetings Officer, **Professor Hilary Lappin-Scott**. Suggestions for topics for future symposia are always welcome. See p. 107 for contact details of Conveners.

Administration of meetings is carried out by **Mrs Josiane Dunn** at SGM Headquarters, Marlborough House, Basingstoke Road, Spencers Wood, Reading RG7 1AG (t 0118 988 1805; f 0118 988 5656; e meetings@sgm.ac.uk).

Offered papers & posters

Many Groups organize sessions for the presentation of short oral papers or allow intercalated papers within their symposia. Offered posters are welcome at all Society meetings.

Offered posters

Each poster should be associated either with the Plenary topic or with a Group. The subject content of the latter should be relevant to the remit of a Group (see website for details); it does not have to relate to the topic of the Group Symposium taking place at a particular meeting. General Offered Posters will not be accepted.

Abstracts

Titles and abstracts for all presentations are required in a standard format and should be submitted through the SGM website. Deadlines for submissions are published in *Microbiology Today* and on the web. For further information contact the Events Administrator.

Spring**08** | Edinburgh International Conference Centre

31 March–3 April 2008 | 162nd Meeting

Plenary Bacterial secretion systems: commonality and diversity

Organizers I.R. Henderson, H.M. Lappin-Scott, P.C.F. Oyston, T. Palmer & C. Winstanley

Speakers

A.J.M. Driessen *The Netherlands*
T. Economou *Crete*
H. Bernstein *USA*
R. Dalbey *USA*
T. Palmer *Dundee*
J. Cox *USA*
O. Schneewind *USA*
W.R. Zückert *USA*
M.H. Saier *USA*
T. Silhavy *USA*
V. Koronakis *Cambridge*
G. Cornelis *Switzerland*
P.J. Christie *USA*
A. Pugsley *France*
I.R. Henderson *Birmingham*
E.G. Dudley *USA*

Other sessions

Hot Topic: Microbes and climate change

Organizer Hilary Lappin-Scott

Type V secretion

Cells & Cell Surfaces Group
Organizers I.R. Henderson & K.R. Hardie

Biological basis of infection control

Clinical Microbiology Group
Organizers S. Lang, M.M. Tunney & M.R. Barer

How to pass the MRCPath Part 2: tips for the exam

Clinical Microbiology / Clinical Virology / Education & Training Groups
Organizers S. Collier, J. Clayton, S. Warren & J. Verran

Vaccines against viral infections from concept to practice

Clinical Virology Group
Organizers P.A. Cane & A.R. Fooks

Rapid diagnostics

Clinical Virology Group
Organizer E. O'Kelly

Communicating microbiology

Education & Training Group
Organizers J. Verran, B. Unsworth & J. Hurst

Microbial biogeochemical cycling

Environmental Microbiology Group
Organizer J.W. McGrath

Commercial industrial bioprocess development

Fermentation & Bioprocessing Group
Organizers S.M.Stocks & P. Bentley

Transmission of viruses through the food chain

Food & Beverages Group
Organizers K.H. Mellis, J. Gray & C.E.D. Rees

The horizontal gene pool: the mobilome and virulence

Microbial Infection / Physiology, Biochemistry & Molecular Genetics Groups
Organizer H.E. Allison

Prokaryotic cell biology

Physiology, Biochemistry & Molecular Genetics Group
Organizers D.H. Edwards

Cyanobacteria, architects of our environment: who are they and what do they do?

Systematics & Evolution / Environmental Microbiology Groups
Organizers A. Willems & A. Wilmotte

Virus modulation of host defences

Virus Group
Organizers R.E. Randall & G.W.G. Wilkinson

Control of virus gene expression

Virus Group
Organizers S.G. Siddell, L.O. Roberts & A.J. Sinclair

Virus Group Workshops

Deadline for receipt of titles and abstracts for offered presentations: **30 November 2007**.

Other**Events**

Third European Congress of Virology

Nürnberg, Germany
1–5 September 2007
www.eurovirology.org/

Virus molecular interactions: therapeutic targets

(SGM/Royal Society for Chemistry joint meeting)

Oxford
16–18 September 2007
www.rsc.org/ConferencesAndEvents/RSCConferences/Virus07/index.asp

14th Conference of the Federation of Infection Societies

Cardiff
28–30 November 2007
www.fis2007.org.uk

Schools Membership costs only £10 a year. Benefits include *Microbiology Today*, advance copies of new teaching resources and discounted fees on SGM INSET courses. To join see **www.sgm.ac.uk/membership**. Enquiries: **education@sgm.ac.uk** or go to **www.microbiologyonline.org.uk** for full details of resources and activities.

2007 MiSAC Competition

Salmonella: from farm to fork

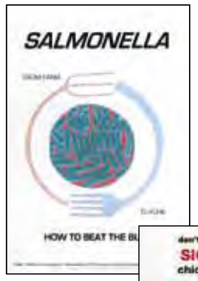
The Microbiology in Schools Advisory Committee runs a competition every year for school students. This year, the brief was to '*produce an eye-catching leaflet to inform the public about the risks of* Salmonella *food poisoning and how to avoid it*'. It was sponsored by the Society for Applied Microbiology and the topic was chosen to tie in with the National Curriculum so competition entries could be produced in the classroom as assessments or teaching aids. Entries were judged in two age categories: Key Stage 3 and Key Stage 4/GCSE. Cash prizes for students and schools went to the top three entries in both categories.

129 schools entered the competition, with 634 KS3 entries and 314 GCSE entries – a record for the competition! The brief gave instructions about format, which had to be adhered to in the judging process. Every year many entries are disqualified because they do not conform to the required format; this year saw a pleasing decline in ineligible entries. It was a shame to see such imaginative pieces of work being taken out of the competition – there were some wonderful shapes, pop-up and stick-on pieces, with the occasional book and poster.

After the first round of screening, the 562 KS3 and 285 GCSE leaflets were taken to London for the final judging. The panel, consisting of committee members, Anthony Hilton, SfAM Honorary Secretary, and Lucy Harper, SfAM communications officer, tackled the KS3 entries first and were astounded at the high standard of work. After lengthy deliberation, the winners were chosen: first prize went to **Hugo Fleming**, Feltonfleet School, second prize to **James Fryatt**, St Aidans RC School, who designed his leaflet around a delicatessen, and third prize to **Katie Wensley**, Sheffield High School. Such was the standard this year, two entries were commended: that of **Emily Barnes**, The Grange School, and **Harry Hitchens**, Prior Park College, for his hilarious '*Don't be a sick chicken*' idea.

It was a hard act to follow, but GCSE entries did not disappoint. First prize went to **Daniel Tolley**, St Anselms College, second prize to **Christopher Lewis**, Bedford School, whose 'Wanted' entry was very original, and third prize to **Camille Raoult**, The Abbey School, for her imaginative cartoon. Yet again, the panel commended two outstanding leaflets: **Jawad Safdar**, Bedford School, and **Emily Kirkham**, The Abbey School.

The professional standard of computer designed entries was equally matched by the skill shown in the hand-made leaflets. Great imagination was evident in the work. A trend was visible in terms of layout and graphics, but the stars of the competition stepped outside the norm and produced some inspired entries. The standard of competition entries seems to get better each year. This is a good indication that students like to get involved in topical issues and to communicate their ideas.



▲ KS3 1st

KS3 2nd ▲

▼ GCSE 1st

GCSE 2nd ▼

Lucy Goodchild,
SGM External Relations Office

Teacher Scientist Network – TSN

Are teachers and scientists a match made in heaven? **Claire Willis** (TSN North East Co-ordinator) certainly hopes so.

▲ TSN North East working with a pupil from a local school. *Claire Willis*

TSN is one of several organizations that puts the scientific community in universities and industries into contact with science teachers in one-to-one partnerships. The partnerships support and encourage teachers, helping them to deliver up-to-date and relevant science through exciting and innovative workshops or through longer term relationships. The partnership is between the teacher and the scientist rather than the school and is an excellent way of delivering CPD (Continued Professional Development) to teachers without leaving the classroom and one in which the teacher is in the driving seat.

The main purposes of the network are:

> To support and encourage teachers in helping them to deliver up-to-date and relevant science;
>
> To help counteract the negative stereotype of scientists;
>
> To encourage scientists to interact with teachers and children.

Many teachers encourage classroom visits from the scientist so that their pupils can talk to a 'real' scientist and get to know him or her as an ordinary person. The scientist may help in the development of new investigations and other activities, perhaps by suggesting different contexts or procedures. Occasionally, they may make a more direct contribution by describing their work. As well as offering advice and expertise, some scientists are able to help with resources and materials for a particular section of school science work. One case study from TSN North East involved a visit by children and teachers from Bowburn Junior School and St Godric's Primary School to Science Learning Centre North East during National Science and Engineering Week.

Dr Paula Martin (a physicist) led a workshop on rocks which used chocolate as a teaching tool to identify different rock types. A second workshop, led by Dr Jane Entwistle (a soil scientist) explored the ways in which soil science is useful to industry and farming and, in particular, how soil identification can be used in forensic investigations to catch criminals.

The partnerships are very flexible and open-ended; the amount of contact varies as do the subjects tackled.

So if you live outside the North East is there some way in which you can get involved with school science? There are other local partnership initiatives around the UK, including TSN Norfolk established in 1994. The North East experience has been inspired by best practice promoted by Norfolk's TSN. In Wales, there is TSN Cymru, and Clifton Scientific forms partnerships in the Bristol area (www.clifton-scientific.org).

The UK Researchers in Residence scheme (which has a very similar ethos to the TSN) is in its first year under the management of Edinburgh University and is run by eight regional co-ordinators.

The scheme aims to enrich the classroom experience of secondary school students by placing a cutting-edge researcher in their school (see also Gradline, p. 134).

Microbiology is often a difficult topic to teach in schools, and it would be great if SGM members would be prepared to give up some time to support teachers and inspire pupils through one of the schemes in Table 1. Teachers wishing to become involved should contact their local co-ordinator.

Table 1. Contact details for various TSN schemes

TSN North East	TSN Norfolk
Coordinator Claire Willis **t** 0191 3706215 **e** claire.willis@durham.ac.uk **w** www.slcs.ac.uk/ne *TSN North East is supported by One North East, the regional development agency.*	**Coordinator** Dr Phil Smith **t** 01603 450304 **e** phil.smith@bbsrc.ac.uk **w** www.tsn.org.uk *TSN was supported by the Gatsby Charitable Trust for 12 yrs, and is currently funded by the Science in Society programme of the Biotechnology and Biological Science Research Council (BBSRC).*
Wales: TSN Cymru	**Researchers in Residence**
Contact John O'Hare-Price **t** 02920 475475 ext. 281 **e** johnohp@techniquest.org **w** www.techniquest.org *TSN (Wales) is supported by the Gatsby Charitable Foundation.*	**Contact** Nicola Cuthbert **t** 0131 650 5384 **e** researchersinresidence@ed.ac.uk **w** www.researchersinresidence.ac.uk *Researchers in Residence is delivered by a consortium led by the University of Edinburgh and funded by Research Councils UK and the Wellcome Trust.*

Gradline aims to inform and entertain members in the early stages of their career in microbiology. If you have any news or stories, or would like to see any topics featured, contact **Jane Westwell** (e j.westwell@sgm.ac.uk).

Promoting science –

Jane Westwell takes a look at the various opportunities for working in science communication.

As a researcher, contemplating your future, you may have already decided that continuing in the laboratory is not on the agenda. You might be planning to abandon science altogether or perhaps, rather than waste all those years of scientific training, you might be looking for a career where you can apply your knowledge and skills. Maybe a role in science communication would be for you?

Science communication is a very broad term that covers a variety of roles in written, broadcast and electronic media. There are also science communicators working in museums, science centres designing and developing exhibits or explaining them to visitors. Some find a role in the media, communications or education offices of research institutes, medical charities, learned societies, universities and other organizations. Science communication is an attractive option for many graduates and postgraduates so the competition for jobs can be quite tough. However, as a PhD (or postdoctoral) researcher, you have the opportunity to develop skills and experience that will strengthen your CV.

Although there are many postgraduate courses in science communication, nothing beats hands-on experience to show you have the drive and enthusiasm to succeed. There are many ways to gain this, either through national schemes or by exploiting opportunities that arise locally.

Promoting science to the general public

There are opportunities for competitions, training and funding to promote your science to a public audience.

▷ *Perspectives* is a poster competition which gives researchers the opportunity to discuss the social and ethical implications of their research. Finalists attend a communication and poster design workshop before preparing posters for presentation to a broad audience at the British Association for the Advancement of Science (the BA) Festival of Science in the autumn. The competition is run by the BA and is open to Research Council funded PhD students and postdocs.

▷ The Royal Society runs training workshops to develop communication skills at a non technical level to a general audience. They take place throughout the year at a cost of £300. RS-funded postdocs are eligible for a subsidised place.

▷ *NESTA FameLab* is an annual national competition to find talented communicators of science and engineering. Prizes include a residential weekend master class in science communication, international speaking engagements, a 2-week internship with Channel 4 and a cash prize of £2,000.

▷ Funding is available if you are planning an activity or workshop. The SGM *Education Development Award* offers up to £1,000 towards small projects that promote microbiology to the public. RCUK offer grants to Research Council-funded scientists to support activities during *National Science Week*. In addition, MRC researchers can apply for money to support projects associated with UK science festivals.

▷ The BBSRC, RCUK and Wellcome Trust websites all provide guidance on promoting science to the general public.

► Janet Hurst and Jane Westwell meeting the gardening public on the SGM stand at the 2006 RHS Chelsea Flower Show. *Ian Atherton*

► Dariel Burdass teaching a class of young children about good and bad bugs. *SGM*

Promoting your career

Science in the media

For people interested in media-related science communication, there is a variety of ways to gain experience.

▷ *BA Media Fellowships* are available to practising scientists with a minimum of 2 years postgraduate experience. Fellows work in placements of 3–8 weeks alongside a national press, broadcast or internet journalist. Information about the scheme and profiles of previous fellows are available on the BA website.

▷ If you would like to develop your skills at writing for a general audience, the *Naked Scientists*, producers of a popular science radio programme and website, are keen to hear from people who could contribute to their activities. There are vacancies in areas such as radio show production, writing and researching material for broadcast, writing articles about topical science, web design and internet multimedia. Contact information, articles and podcasts of the radio shows are available on the website.

▷ The BBSRC run media training courses for their researchers. The Royal Society also run media training courses with subsidised places available to RS-funded researchers.

▷ Budding science writers can download *So you think you want to be a science writer?* from the Association of British Science Writers (ABSW) website. The booklet is packed full of handy tips and information with insights from professional science writers and journalists.

▷ Science writing competitions are another good way to practise writing for a general audience. Check out the *Wellcome Trust and New Scientist* essay competition or the *Daily Telegraph and Bayer* annual science writing award. Both competitions offer a range of cash prizes and a work placement for the winner. MRC-funded PhD students can enter the *Max Perutz science writing prize* and win up to £1,000.

▷ *Sense About Science's Voice of Young Science* network encourages early career scientists to communicate with the media. The website provides useful guidance.

Volunteering in schools

It may sound daunting but explaining science (and keeping it interesting) to a group of school students can be a very rewarding way of practising your communication skills. There are schemes to facilitate this.

▷The *Science and Engineering Young Ambassadors* scheme is open to any scientist who would like to enthuse young people about the science and technology that surrounds them. Individuals who successfully register with the scheme receive training to prepare for their first activity as an ambassador. Projects are diverse and include giving talks, helping to deliver practical or supporting project work. Information on being a role model is available in a *Taking a leading role: a good practice guide* on The Royal Society website.

▷*Researchers in Residence*, open to Research Council- and Wellcome Trust-funded students and postdocs, places researchers into secondary schools to support practical science activities. Volunteers receive training (communication and preparation of activities) before placement.

▷For information on *Teacher Scientist Networks*, see p. 132.

▷BBSRC runs a network of local coordinators across the UK. These are scientists who develop links with schools in their region, maintaining contacts and setting up collaborative activities between BBSRC scientists and the schools.

▷The Royal Society funds *Partnership Grants* which offer up to £3,000 to foster links between scientists and school teachers.

▷SGM *Education Development Award* public understanding awards can also be used to support activities in schools.

▷*Junior Café Scientifique* – for secondary school pupils – is currently being piloted in regions of the UK. If you would like to introduce your science to a young audience then participate in a lively discussion, you should investigate this opportunity. Currently the cafés are concentrated in Yorkshire, north-west and south-west England.

If you are inspired to take microbiology into the classroom, there are lots of resources available to support you. The SGM has produced teaching resources that are freely available to members planning to work with school students. Safety is very important and safe practice in a university lab does not necessarily translate to schools. Guidance is also available from the External Relations Office. The BBSRC website includes *A practical guide to microbiology in primary schools for researchers* – essential reading before preparing to introduce younger children to the wonderful world of microbes.

The wealth of opportunities to gain experience reflects the huge scope of science communication but don't forget to explore local possibilities too. Maybe your organization is involved in a public engagement activity such as the Royal Agricultural Show, the Chelsea Flower Show, the Royal Society Summer Exhibition, or perhaps a local science festival. If it is, you can be sure that there will be a hard pressed organizer delighted to welcome another pair of hands. Some departments organize hands-on activities for school students at university open days or during *National Science Week*. Look out also for opportunities to write in departmental or university newsletters. Every piece of experience you can accrue and every skill you develop will be an excellent addition to your CV.

Good luck!

Further Information

Schemes

www.researchersinresidence.ac.uk/rir/

www.the-ba.net/mediafellows

hwww.setnet.org.uk/ambassadors_seas.cfm

Competitions

www.the-ba.net/the-ba/ScienceinSociety/_Schemes_and_awards/perspectives/index-2.html

www.famelab.org/

www.mrc.ac.uk/newsviewsandevents/maxperutzaward/index.htm

www.science-writer.co.uk/ – *Daily Telegraph and Bayer* annual science writing award

Funding

www.rcuk.ac.uk/scienceweek/default.htm – grants for RCUK funded researchers to fund *National Science Week* activities

www.sgm.ac.uk/grants/dtf.cfm – *SGM public understanding of microbiology grants*

Advice

www.bbsrc.ac.uk/support/communicate/training/notes.html – Communicating with the public guidance notes

www.bbsrc.ac.uk/support/school/practical_guides.html – safety in primary schools and working in schools

www.absw.org.uk/SYWTBASW.htm – *So you want to be a science writer?*

General

www.bbsrc.ac.uk/support/communicate/Welcome.html

www.thenakedscientists.com

www.mrc.ac.uk/Careers/opportunities2007/index.htm

www.wellcome.ac.uk

www.royalsoc.ac.uk – The Royal Society, details of grant schemes, training workshops and *Taking a leading role*: a good practice guide

www.juniorcafesci.org.uk/ – *Junior Café Scientifique*

www.senseaboutscience.org.uk

www.big.uk.com – *British Interactive Group*

◀ An SGM display educating the public about microbes and food at an event in Cirencester. *SGM*

A job in… Science communication

Lucy Chappell recently made the move from PhD student at the Institute for Animal Health to Press and Communications Officer at the Health Protection Agency. Jane Westwell asked her to share her experience and any useful tips.

Profile

Age 26
Present occupation Press and Communications Officer, Health Protection Agency
Previous employment Research Assistant, University of Aberdeen (before my PhD)
Education Institute for Animal Health, PhD on *Salmonella pullorum disease in chicken*; University of Aberdeen, BSc Zoology

Q Why did you decide to find work out of the laboratory?

About halfway through my PhD I decided that I didn't want to do a postdoc. I enjoyed the science, but I could never get particularly excited about the lab work, so I decided to look for a job out of the lab.

Q What does your current job involve?

My current job has two sides to it. The press side involves dealing with media enquiries, writing briefings and producing both pro-active and re-active press statements. The communications side of the job involves making technical scientific information more user-friendly and accessible to the general public.

Q Did you have any experience in science communication before applying for your current job?

Although I knew that a postdoc wasn't for me, I didn't know what else I was qualified for or even wanted to do. I decided it might be helpful to gain some new skills and experiences, to find out what I was good at and also to enhance my CV. The first thing that caught my eye was Researcher in Residence. I spent a week in a local school teaching 'disease and defence' to pupils ages 14–16, and thoroughly enjoyed it! This encouraged me to get involved in more activities with schools which demonstrated and improved my skills for communicating technical information to a non-technical audience. I also wrote several articles on science communication to encourage other scientists to get involved in public engagement activities and this gave me experience of writing magazine-style articles.

I also got involved in *Biotechnology YES*, a competition aimed at PhD students. It involved creating a hypothetical biotechnology company, and pitching to venture capitalists in a 'dragon's den' scenario. It was hard work, but I gained a lot of knowledge, skills and experience in marketing, finance and project management, and it gave me the chance to communicate science to a business audience.

If anyone needed volunteers for anything involving communication or public engagement, I was the first to put my hand up. The experience I gained from these activities probably helped me to get my current job.

Q How did you balance your research commitments with gaining new experience?

To gain the experience necessary to enhance my CV, I had to plan my time well. Although my research always took priority over other activities, I set aside enough time for both and made sure I didn't feel guilty for taking time out of the lab. I found that spending time away from the lab wasn't only useful in helping me to gain new skills, it also helped to keep me motivated in my PhD research.

Q How have you found the transition from lab-based to administrative work?

Working in an office is very different from working in a lab. One big difference is the pace of work. In the lab you can plan what you will be doing next week and even next month. In the press office, every day is different and the pace is often very fast. I like working to tight deadlines and not knowing what is coming next! The transition from the lab to the office was a little strange at first, but it didn't take me long to get into the swing of it.

Q What aspect of your work gives you the most job satisfaction?

Having the opportunity to make technical information more accessible to a wider audience. As a scientist, you are trained to write in very technical language. As a science communicator, you need to be able to translate the science into something that the general public can understand.

Q What advice can you offer people looking for a similar career?

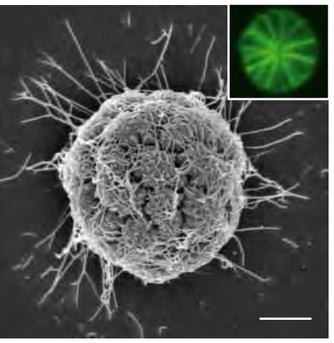
The qualifications and the skills you gain as a scientist make you very employable, but do not necessarily set you apart from other scientists when going for a career out of the lab. It helps if you can demonstrate that you have the necessary skills, and it is important to balance them with other relevant skills. My advice is to get as much practical experience in science communication as possible and, above all, enjoy getting it!

hotoffthepress

Science writer **Meriel Jones** takes a look at some recent papers in SGM journals which highlight new and exciting developments in microbiological research.

Multicellular, magnetotactic bacteria

Abreu, F., Martins, J.L., Silveira, T.S., Keim, C.N., Lins de Barros, H.G.P., Gueiros Filho, F.J. & Lins, U. (2007). '*Candidatus* Magnetoglobus multicellularis', a multicellular, magnetotactic prokaryote from a hypersaline environment. *Int J Syst Evol Microbiol* **57**, 1318–1322.



Magnetotactic bacteria, as the name implies, sense the Earth's magnetic field and use this to guide their movement through water. The cells align themselves and swim together along magnetic field lines. This ability comes from small structures within the cells, called magnetosomes, that contain crystals of the iron sulfide-containing mineral magnetite or greigite. Although they intrigue microbiologists, only three cultivated strains have been assigned to properly described species. Scientists from Brazil have now added to this number by collaborating to provide a thorough description of one surprising species of magnetotatic bacterium, '*Candidatus* Magnetoglobus multicellularis'. Although it has the typical cell structure of bacteria, the cells stay together like a multicellular organism. When the researchers broke the aggregates apart, the cells died, reinforcing the fact that the organism is truly multicellular. They collected the bacterium from Araruama lagoon, a large, highly saline coastal lagoon in Brazil. The cells exist as groups of 10–40 with co-ordinated motility that swim in either straight lines or a helical direction at 90 µm per second. Each cell has a flagellum and they fit together in a spiral to form a sphere 6–9.5 µm across. The group remains together as each cell grows until the volume doubles. They then all divide simultaneously, maintaining the spherical arrangement, and separate into two new spheres.

The researchers were able to use a magnetic field to isolate the bacteria from the lagoon water. The cells were in an oxygen-free zone of the lagoon sediment, about 4 cm below the surface, where there is the iron sulfide required to make magnetosomes. Phylogenetic analysis showed that the bacteria were members of the *Desulfobacteraceae* family, but not similar enough to be members of any characterized genus.

◀ A scanning electron micrograph of '*Candidatus* Magnetoglobus multicellularis'. Note the rather straight flagella. Bar, 2 µm. The inset shows a fluorescence microscope image of a micro-organism stained with a lipophilic dye, which highlights the cell outlines. *Ulysses Lins*

Advances in norovirus research

Chaudhry, Y., Skinner, M.A. & Goodfellow, I.G. (2007). Recovery of genetically defined murine norovirus in tissue culture by using a fowlpox virus expressing T7 RNA polymerase. *J Gen Virol* **88**, 2091–2100.

The noroviruses, also called winter-vomiting viruses and Norwalk-like viruses, are the most common cause of viral gastroenteritis, affecting up to one million people in the UK each year. These viruses cause more than 85 % of all the non-bacterial gastroenteritis in Europe. Symptoms include nausea, fever, projectile vomiting and watery diarrhoea. These start within a day or two of infection and last for up to 3 days, then fortunately end. Most people make a full recovery, but the vulnerable become dehydrated and need hospital care. Unfortunately, the virus is easily spread from person to person, and can survive on surfaces for days. In addition, there are many different varieties, and recovery from one does not provide protection from others. Apart from drinking to prevent dehydration, there are no specific treatments at the moment.

Noroviruses infect many other animals as well as people. Researchers from Imperial College, London, have now developed a method which allows the generation of infectious noroviruses entirely from cDNA. This is a major advance in the field as, until now, although it has been possible to grow the murine virus in tissue culture, mutations could not be introduced into the virus, making it very difficult to learn exactly how the virus reproduces and causes disease.

After careful thought about the ways that people have tried to grow this and related viruses, the researchers carried out experiments that proved that one component of the systems usually used in attempts to grow norovirus actually inhibited viral replication. Replacing this was a key part of their success. They also tested several different cell cultures to see which was the best to use. Their final, and very important, test was to make a change to the genes in the norovirus, infect the cells and then check that all the new viral particles had the same change. This very careful and detailed technical study has now made it possible to make murine norovirus mutants that will allow the characterization of the basic biology of the virus and the determination of the function of many of the viral proteins. It will also be possible to identify methods of attenuating the virus, which has implications in terms of the rational design of attenuated norovirus vaccines.

Improving cholera risk assessment

Vital, M., Füchslin, H.P., Hammes, F. & Egli, T. (2007). Growth of *Vibrio cholerae* O1 Ogawa Eltor in freshwater. *Microbiology* **153**, 1993–2001.

The bacterium *Vibrio cholerae* causes cholera. This water-borne disease is a major problem worldwide in areas without good sewage disposal or clean drinking water. Although the symptoms of diarrhoea, vomiting and leg cramps are often mild in healthy people, the toxin produced by the bacteria causes such profuse watery diarrhoea in around 10 % of patients that they die within hours.

Cholera is prevalent in Africa, Asia, and Central and South America. Assuring clean drinking water and adequate sewage treatment are the most important countermeasures and it is important to know what conditions prevent survival and growth of the bacteria. The EU is supporting a project to investigate new technologies for the drinking water industry. As part of this, researchers in Dübendorf and Zürich, funded in part by LABOR SPIEZ, have been reviewing the contradictory data about the environmental conditions required by *V. cholerae*.

V. cholerae has been reported from very nutrient-poor natural water systems as well as the nutrient-rich human gut. Salinity seems to be an important factor, with saline waters, such as estuaries and the sea, appearing to support the bacterium best, whereas in fresh water it appears to be unable to grow; however, it has also been found in fresh water contaminated by human sewage. Warmer temperatures appear to favour outbreaks of cholera and in the laboratory the bacterium grows at 10–25 °C.

The researchers first developed a very sensitive fluorescent immunological detection system to count *V. cholerae* cells using flow cytometry. In the laboratory they used Swiss tap water and Evian mineral water as examples of clean and pure waters and showed that *V. cholerae* could not grow in either of them. Their samples of natural waters from Swiss lakes and rivers were free of *V. cholerae*, but when the bacterium was added to sterile fresh water, it grew, even when forced to compete with the natural bacteria from these environments. The cholera bacterium grew best after a moderate amount of salt was added to the water, and at a warmer temperature (25–30 °C). The data were used in mathematical models of bacterial population growth that strongly suggested that the lake water and bacteria and *V. cholerae* compete for nutrients without any other interaction.

These experiments are the first to show that not only can *V. cholerae* survive, but it can grow in fresh water. The fact that it grows better at higher temperatures means that global warming may make the environment more suitable for it, even in Europe. However, these experiments indicated that temperature has no influence on the outcome of the competition of *V. cholerae* with the natural fresh water bacterial communities, i.e. it was able to compete equally well at 20 as at 30 °C. The next step will be to use their methods to see what happens over longer time periods and in more realistic settings to improve risk assessment for cholera.

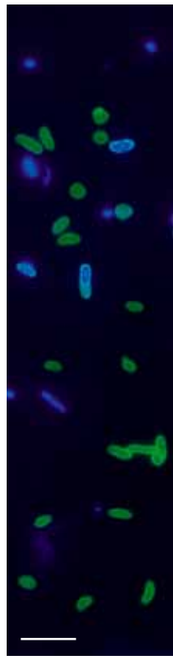
Peptide antibiotic against *C. difficile*

Rea, M.C., Clayton, E., O'Connor, P.M., Shanahan, F., Kiely, B., Ross, R.P. & Hill, C. (2007). Antimicrobial activity of lacticin 3147 against clinical *Clostridium difficile* strains. *J Med Microbiol* **56**, 940–946.

Clostridium difficile is the most important cause of hospital-acquired bacterial diarrhoea. The bacterium is a normal inhabitant of the human gut in a few percent of the adult population and generally does not cause problems, unless removal of other normal members of the gut flora allows it to multiply unchecked. This means that it can be a very unpleasant follow-up to antibiotic treatment for other infections, especially in the elderly. *C. difficile* produces toxins that damage the cells lining the gut, with consequences that range from a minor digestive upset to ulceration, bleeding and death. The number of cases reported in the UK has increased from less than a thousand a year in the 1990s to 42,625 in patients aged 65 or more in England in the first 9 months of 2006 – some of this can be explained by improved detection and reporting, but there has definitely been an increase in the number of actual cases.

Current treatments are very limited and have a high failure rate. There is therefore a pressing need for new therapies. Researchers in Ireland have been testing a lantibiotic (lanthionine-containing antimicrobial peptide) against *C. difficile*. They focused on lacticin 3147 produced by *Lactococcus lactis*. It consists of two peptides, and is active at physiological pH. It is toxic to many Gram-positive bacteria. One of the lacticin peptides binds to lipid II, a cell wall precursor, and prevents wall biosynthesis. When combined with the second peptide, pores are formed in the cell wall, resulting in cell death.

The researchers used strains of *C. difficile* isolated from patients with diarrhoea and inflammatory bowel disease as well as from a healthy individual. They measured the level of lacticin 3147 required to inhibit growth of the bacteria in culture and discovered that it was at least as effective as the antibiotics used in current treatments. This encouraged them to undertake further investigations to see whether lacticin 3147 could be part of a new, more effective, therapy. As a first step, the researchers tested its effects on mixed bacterial cultures designed to simulate the human gut. Lacticin 3147 reduced the number of all Gram-positive bacteria, not only *C. difficile*. Some of these Gram-positive bacteria are beneficial, so measures to protect them, or to administer lacticin 3147-tolerant strains along with the lantibiotic, would be required in a clinical therapy. However, the intractability of *C. difficile* diarrhoea is such that the prospect of a therapy involving lacticin 3147 is receiving very serious attention.



▲ Fluorescence micrograph of a mixture of *V. cholerae* (green) with natural fresh water bacterial flora (blue). Bar, 2.5 µm. *Thomas Egli*

▶ Three-dimensional structure of the two peptides of lacticin 3147. *Mary C. Rea*

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Food Microbiology: Fundamentals and Frontiers, Third Edition

Edited by M.P. Doyle & L.R. Beuchat
Published by American Society for Microbiology (2007)
US$169.95 pp. 1,056
ISBN 1-55581-407-6

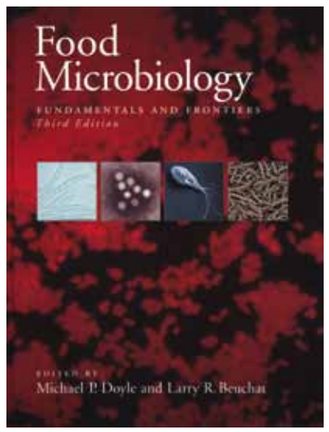
This book aims to complement other texts in this diverse field of study by emphasizing molecular and mechanistic aspects of the subject. The main updating in this third edition focuses on food-borne pathogenic bacteria and is most welcome as there has been a positive deluge of information published in the last 6 years since the previous edition. The overall format of the book is unchanged, although there have been the inevitable authorship changes of individual chapters.

The introductory section now includes a topical overview of antibiotic resistance and a chapter on biosecurity which emphasizes US-based risk assessment protocols. In the food spoilage section, the meat, poultry and seafood chapter has been extensively rewritten to include clear information on the origins and mechanisms of organoleptic changes in spoilage, whereas the chapter on dairy projects is lightly updated. Sensibly, plant product spoilage has been split into chapters on fruit and vegetables, and cereals and nuts with a slight increase in content.

As in the previous edition, the major section of the book (13 chapters) deals with food-borne pathogenic bacteria on a by species basis, nearly all of which include a good coverage of up-to-date molecular information. *Enterobacter sakazakii* is now included. Unfortunately, the *Clostridium botulinum* chapter just pre-dated the recent publication of the genome. Although the chapter on *Campylobacter jejuni* includes useful information on *Arcobacter* spp. and other *Campylobacter* spp., it was disappointing that for molecular information the author merely cited his own review in the *Manual of Clinical Microbiology*, recently produced by the same publishers. Whilst understandable, this is unfortunate as the readership of the two books is likely to be very different. A usefully updated review of food-borne disease epidemiology concludes this section.

The 3-chapter section on mycotoxigenic moulds is largely unchanged, save for updated references, as is the section on food-borne and water-borne parasites.

The single chapter on viruses has been completely rewritten by new authors in a user friendly manner which should appeal to more general readers. A chapter on prions is new for this edition. It takes a very practical approach to the consequences of BSE for human health and includes much information from the CJD Surveillance Unit in Scotland.



The useful 3-chapter section on physical, chemical and biopreservation methods has received some minor updating.

The section on fermentations and beneficial micro-organisms spans a wide field from traditional dairy and meat products to wines, coffee and cocoa. Most chapters have received just light updating of references, although an extensive reorganization of the indigenous fermented food chapter improves accessibility for the general reader. Probiotic and prebiotics, which are now considered sufficiently mainstream to be moved into this section, have benefited from inclusion of recent information on the molecular biology of lactic acid bacteria and on well designed experiments to clarify potential health benefits.

As in previous editions of this book, the final section on advanced techniques tries to take a forward look, or to 'scope' potential developments in the field. Three of the chapter titles appeared in earlier editions. In the case of Rapid methods of detection of food-borne pathogens, sensibly only a brief summary of previously given information is included before providing a well balanced critique of the present situation. With the frequent introduction of yet more new rapid methods the author highlights three major concerns: 1, lack of published performance data on these methodologies in peer-reviewed journals; 2, the need for reassessment of the potential health risks of (a) foods previously analysed by less sensitive methods, subject to loosely worded legislation, e.g. not detectable, and (b) false negative results which are accepted without further confirmation; and 3, the lack of truly integrated governmental validation procedures. The chapter on modelling has been extensively remolded to give a clear comparison of the different types of model and their applicability, whilst many formulae have been removed. The HACCP chapter is largely unchanged.

A new chapter on 'omics' gives a clear introduction to the value of increases in knowledge of genomics and proteomics for our understanding of both wanted and unwanted activities of microbes in foods and the potential to control them. It is appropriate that the final chapter extends this topic to molecular source tracking and molecular sub-typing of microbes in foods.

Overall, the book does span the whole field of food microbiology whilst devoting about half its content to food-borne pathogenic bacteria. Its utility is aided by good indexing but, one detraction is the strange positioning of all the colour plates, which are exclusively mentioned but not fully cited in chapters 21, 42 and 44, as an unindexed block after chapter 12. This will leave many readers baffled. Despite this and a price which puts it out of the reach of students who would find such a book most useful, it is certainly a recommendable library purchase.

***Martin Collins**, Queen's University Belfast*

Microbiological Analysis of Red Meat, Poultry and Eggs

By G. Mead
Published by Woodhead Publishing Limited (2006)
£135.00/US$255.00/€195.00 pp. 364
ISBN 1-84569-059-1

On the face of it, this book might appear to have a rather narrow focus on just three foods. The reality is that they are the source of most food-poisoning incidents, either as primary foodstuffs or as ingredients, in the UK and widely in Europe and parts of North America. Therefore, the book concentrates on *Campylobacter*, *Salmonella* and *E. coli* O157, but overall its main strengths are first in the general treatments of the sampling, detection, enumeration and identification of food-borne pathogens, and second in the microbiological aspects of quality assurance/control, including legislation. The chapters are authoritatively written as reviews, well referenced generally to 2005, rather than laboratory manuals of methodology, and will be of most use to those working in the food industry, plus students studying food science courses. Given the broad range of topics and hefty price tag, the book is unlikely to find many personal purchasers, but it should have wide institutional appeal.

***Nick Russell**, Imperial College London*

Food Safety: Old Habits, New Perspectives

By P. Entis
Published by American Society for Microbiology (2007)
US$49.95 pp. 414
ISBN 1-55581-417-5

The author reminds us of the importance of a co-ordinated approach to food safety by providing the reader with key examples of food-borne disease outbreaks associated with breaches of biosecurity, food processing and handling along the food chain to the consumer. Examples of the major food-borne pathogens are well represented throughout the book and the way the book is organized and illustrated using different outbreak investigation scenarios enables the reader to capture the importance of a holistic approach to food safety. The author has carefully balanced the amount of scientific detail to ensure that aspects of the book will be of interest not only to those professionals involved in food safety, but also undergraduate students interested in food microbiology and public health.

The author focuses predominantly on human outbreak investigations to illustrate some of the key messages for producing safe food. However, it should not be forgotten that sporadic infections comprise a large proportion of human food-borne illness. I think the book could have benefited from an introductory chapter outlining the relative importance of food-borne pathogens and foods to the burden of disease. That said, I found it an informative and enjoyable read that should appeal to a wide readership.

***Chris Thorns**, Veterinary Laboratories Agency*

Reviews on the web

Reviews of the following books are available on the website at www.sgm.ac.uk/pubs/micro_today/reviews.cfm

Biofilms in the Food Environment

Food Irradiation Research and Technology

Molecular Biology of Spirochetes

Oxford Dictionary of Biochemistry and Molecular Biology, 2nd edn

Techniques for Molecular Biology

From a to α: Yeast as a Model for Cellular Differentiation

Burkholderia *Molecular Microbiology and Genomics*

The Periplasm

GM Crops – The Impact and the Potential

Translational Control in Biology and Medicine

Diagnostic Medical Parasitology, 5th edn

AIDS Vaccine Development: Challenges and Opportunities

Antimicrobial Chemotherapy, 5th edn

Proteomics of Microbial Pathogens

Globalization, Biosecurity and the Future of the Life Sciences

Gene Transfer: Delivery and Expression of DNA and RNA: A Laboratory Manual

Microbial Source Tracking

Modern Multidisciplinary Applied Microbiology: Exploiting Microbes and their Interactions

Gene Cloning: Principles and Applications

Philosophical Transactions of The Royal Society B Biological Sciences, Vol. 361, No. 1475

Antisepsis, Disinfection, and Sterilization: Types, Action, and Resistance

Handbook of Brewing, 2nd edn

Fermentation Microbiology and Biotechnology, 2nd edn

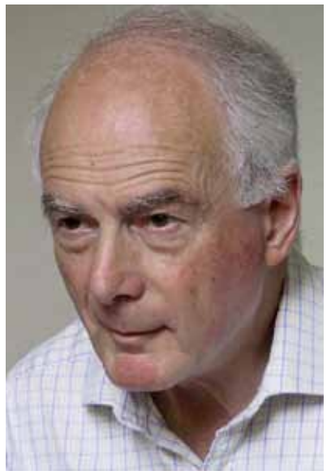
Malicious Microbes: Bacterial Infections Explained

Candida *Comparative and Functional Genomics*

Modelling Micro-organisms in Food

obituaries

Professor Simon Baumberg (05.03.**1940**–11.04.**2007**)



Simon Baumberg was one of the most respected members of the UK microbiology community. Simon went to Merton College, Oxford on a scholarship in 1958 and graduated in chemistry in 1961. Initially he was intent on a career in chemistry but as an undergraduate, he acquired a life-long interest in microbial genetics. Following his graduation, Simon joined the Oxford Physical Chemistry Laboratory to study for a doctorate under the supervision of Nobel laureate, C.S. Hinshelwood. Even at the outset of his research career, Simon demonstrated a remarkable ability for independent critical thinking.

Rejecting the thesis of his supervisor that bacteria adapted to changes in their environment via a process involving purely chemical kinetics, Simon quickly identified the innovative work of Jacob and Monod at the Institut Pasteur and Bill Hayes at the Hammersmith Hospital who showed that gene regulation rather than 'chemical kinetics' was the basis for the extraordinary ability of bacteria to respond to changes in their environment. The results from his thesis, published by Simon as the sole author, have stood the test of time. After the award of his doctorate, Simon then spent two highly enjoyable and productive years as a postdoctoral fellow in the laboratory of one of the pioneers of the study of gene regulation, Dr Henry J. Vogel, Rutgers University, New Jersey.

Simon returned to the UK in 1966 to take up the appointment of Lecturer in the newly formed Department of Genetics at Leeds University. He was Head of Department on several occasions and remained at Leeds until his retirement in 2005. His research on bacterial gene expression focused on arginine metabolism in *Bacillus* species and antibiotic synthesis in *Streptomyces* species. He discovered the AhrC protein of *B. subtilis*, a repressor/activator of arginine metabolism, and with Peter Stockley analysed its activation and interaction with DNA. Together with Kenny McDowell, he analysed the complex physiological controls involved in the regulation of the biosynthesis antibiotics such as actinorhodin from *S. coelicolor*.

Simon was a true academic with a keen sense of what was important and a strong dislike for what he often saw as self-serving administration. As a teacher he was universally admired for his gentle but persuasive approach to learning and many of his former students were privileged to become his friends. When Simon was eventually made a Professor by Leeds University, many felt this was a long overdue recognition of his services, not only to that university, but also to the UK genetics and microbiology communities.

Throughout his career Simon was valued as much for his sound judgement, integrity and sense of fair play as for his outstanding scholarship. He was committed to the old-fashioned concept of the 'common good' – through his involvement with scientific research, the students he taught, the Jewish community, and his kindness to everyone that he met in all walks of life. Simon served as General Secretary and Vice-President of the Genetics Society, Senior Editor of the *Journal of General Microbiology* (now *Microbiology*), Convener of the Physiology, Biochemistry and Molecular Genetics Group and elected Council Member for the SGM. He was elected as an Honorary Member of the SGM in recognition of his contribution to the Society over more than 20 years.

Simon served on a number of committees of the Medical Research Council, including chairing the Advisory Board, the Non-Clinical Training Fellowships and Career Development Panel and the Stem Cell Bank Users Liaison Committee. He was also a member of the Biological Sciences panel for the 1996 and 2001 Research Assessment Exercises and was subsequently called upon to provide honest and perceptive advice to many university departments preparing for the 2008 exercise. He listened carefully to opinions and was kind and attentive to the most junior member of any team, committee or organization for which he worked. He was also a gentle though perceptive critic, whether examining students or having to explain to an influential scientist why he or she would not be getting the research funds to which they felt they were entitled. In recognition of his service to science, he has awarded an OBE in the 2005 New Year's Honours list – an award he always found amusing, given his instinctive lack of self-importance.

Simon was an active and committed member of the Leeds Jewish community. He was actively involved in the Soviet Jewry campaign during the 1980s. More recently he served as chair of Leeds Masorti community, and on the board of Sinai reform Synagogue. He was on the organizing committee of Leeds Day Limmud, and recently was appointed as its chair. In all these various activities his contribution was immeasurable; the breadth of his interests and associations, the depth of his knowledge, and the civility of his manner were unparalleled. His contributions to the cultural and religious life of the community will be sorely missed.

Despite remaining active in the scientific and Jewish communities, Simon found time in retirement for his long-standing passion for hill-walking and his rekindled love of choral singing. All his life he had a passion for classical music, particularly the twentieth century masters, and history. He loved debate and discussion, talk and listening. His activities were interrupted by a minor stroke earlier this year, and it was during his treatment that pancreatic cancer was discovered. Despite his considerable achievements, Simon was an extraordinarily modest man who would have been slightly bemused at the hundreds of friends and colleagues who turned out on an unseasonably hot Sunday afternoon in early April to pay their respects at his funeral. His spirit and deep sense of humanity live on in Simon and Ruth's sons Jeremy, Adam and Ben and four grandchildren, Lizzie, Cassie, Danny and Raphael.

Colin Harwood, Newcastle

Professor Dr Miloslav Kocur (**1929–2006**)

Known to so many people in the microbial taxonomy and culture collection worlds, the passing of Miloslav Kocur has meant the loss of a big-hearted man with great personal and professional qualities. He will be greatly missed.

Milos studied microbiology at the University of Brno, Czechoslovakia, and after his graduation was appointed as an assistant lecturer in the Department of Microbiology. Here, in 1964, under the encouragement of Professor Martinec, he started the collection of bacteria, and within a short period of time he succeeded in building up an institute of considerable importance. The Czech Collection of Microorganisms (CCM) soon became a member of the World Federation for Culture Collections (WFCC) and the European Culture Collections' Organization (ECCO) to which he contributed significantly in many ways. He served as a WFCC Committee member and was Chairman of the ECCO for two terms. In 1981, he organized the WFCC's *IVth International Conference on Culture Collections* in Brno and at the same time prepared an international course for the curators of microbial collections from developing countries, under the aegis of UNESCO.

Milos was an enthusiastic champion of rising young microbiologists and a tireless organizer of conferences. He is remembered particularly for the regular events on the taxonomy of bacteria held at the CCM. These and similar events always enabled a rich exchange of ideas and put Brno firmly on the microbiology map. As many of his friends have remarked, Milos was a great bridge-builder.

His professional and communication skills were recognized by many national and international organizations. For several years he was Chairman of the Czechoslovak Society for Microbiology (CSM) and he contributed to the founding of the Federation of Czechoslovak Collections of Microorganisms and to the co-ordination of its activities. He became Chair, Vice Chair or President of several international organizations, including FEMS (1988–1993), ECCO (1986–1993), CSM (1990–1992 and honorary member), and was an IUMS Member at Large (1991–1994) He was also Vice Chair and Member of various subcommittees of the ICSB (1978–1990), and a member of the editorial boards of three publications.

In his scientific work he specialized in the taxonomy of bacteria, focusing particularly on the family *Micrococcaceae*. Over the years, he became a highly regarded specialist with an associated wide breadth of knowledge. He was author/co-author of several chapters of *Bergey's Manual of Determinative Bacteriology/Systematic Bacteriology* and published over 140 scientific papers. His contribution to taxonomy was also recognized by the naming of a novel bacterial species and a new genus in his honour, *Planococcus kocurii*.

This record shows that he was a major contributor to bacterial taxonomy and to the development of microbial resource centres, and his professional achievements will long stand the passage of time. But for those that knew and worked with him, he will be remembered best for his cheerful smile, his consideration for others and for his enjoyment of life. We mourn his loss and send deep condolences to his family.

Barbara Kirsop, Electronic Publishing Trust for Development, and colleagues

comment

bovine tb and badgers

The culling of badgers to control the spread of bovine tuberculosis has been going on for over 30 years. **Chris Cheeseman** reviews the effectiveness of this strategy, in the light of a new study.

The study of wildlife ecology is a fascinating subject, where processes in one part of the natural system can have profound effects on other, apparently unconnected components. Ecological processes impact on pathogen dynamics, particularly in wild animal populations, and their understanding can be of crucial importance in developing effective disease management strategies. Bovine tuberculosis (bTB) is a case in point; this is a serious disease problem which costs taxpayers and farmers a great deal of money. While the human health risks are minimal, there is a potential for human infection and the impact on the farming industry is significant. Badgers were first implicated in the spread of bTB to cattle herds in southern England in the 1970s; since then further evidence has emerged to support the contention that badgers are indeed involved. The extent of their involvement, however, has always been unclear. Nevertheless, badger culling has often been part of historic strategies to control the potential for spread to cattle, first by gassing setts and later by various strategies involving trapping and shooting. There is currently a debate as to whether badger culling should once again form part of the control strategy for this disease.

Back in the early 1980s a handful of ecologists ventured to suggest that it was possible that the impact of culling itself on the behaviour of badgers could potentially increase the risk of spreading disease. In 1996 an independent review by Sir John Krebs recommended a field trial, and a study was designed whereby two potential culling policy options – 'proactive' and 'reactive' culling of badgers – could be scientifically assessed. Implementation of what has become one of the largest field experiments ever undertaken, at a cost to taxpayers of £50 million, was the responsibility of the *Independent Scientific Group on Cattle TB* chaired by Professor John Bourne. After nearly 10 years of work, involving meticulous attention to scientific rigour, the ISG's report, *Bovine TB: The Scientific Evidence*, has now been published. In summary, the ISG conclude that neither the proactive or reactive culling of badgers can be recommended as a means of controlling bTB in cattle. Reactive culling, where badgers were trapped on and around farms where TB outbreaks had occurred, led to an overall increase in cattle TB of approximately 26%. Proactive culling, where the strategy was to trap as many badgers as possible annually in cattle TB hot-spots, resulted in a 23% reduction in cattle TB in the core of the culled area, while there was an increase of similar magnitude on the edge, thus negating any potential benefits over the time and scale of the study. These somewhat counter-intuitive negative effects of culling were explained by what has been termed the 'perturbation effect', which is simply the disruption of the stable social structure typically found in undisturbed badger populations, leading to increased movement and enhanced contact, both between badgers and between badgers and cattle. Indeed, it is entirely plausible that past culling policies have exacerbated the spread of bTB.

As the ISG's results have emerged, they have been challenged, mostly from the farming and veterinary communities. Some of the criticism claimed that the trial was scientifically compromised. In response the ISG have made clear that the trial design, field activities, data collection and management, data analysis and other aspects of their work have been subjected to ongoing independent audit. The results of the trial have been subjected to the rigours of peer review, prior to being published in some of the most prestigious and demanding international scientific journals. Another criticism has centred on the charge that not enough badgers were killed, and that if badgers were gassed in their setts, for example, the positive effects of culling would increase and the negative effects would diminish. Trapping efficiency in the trial was high and consistent with design expectations, and even if more badgers could have been killed, there is no evidence to suggest that this would have resulted in additional benefits in terms of decreased cattle breakdowns. The existing control strategy for this disease includes regular herd testing to identify infection in cattle, combined with the slaughter of reactors. In addition, new pre-movement testing requirements for cattle have been introduced, reflecting the scientific evidence that more rigorous application of cattle-based measures plays a central role in the control of this disease. Other work is underway to examine vaccines and improved farm husbandry to reduce disease transmission risks from wildlife. Even putting aside arguments about wildlife conservation, in a country where our indigenous fauna is under ever increasing pressure, the conclusion from the recent badger culling trial is profoundly simple: *we cannot disrupt badger populations by culling without potentially making the cattle TB problem worse.*

Chris Cheeseman
Former Head of Wildlife Team,
Central Science Laboratory

Please note that views expressed in Comment do not necessarily reflect official policy of the SGM Council.

▲ *Photos.com/Jupiter Images*